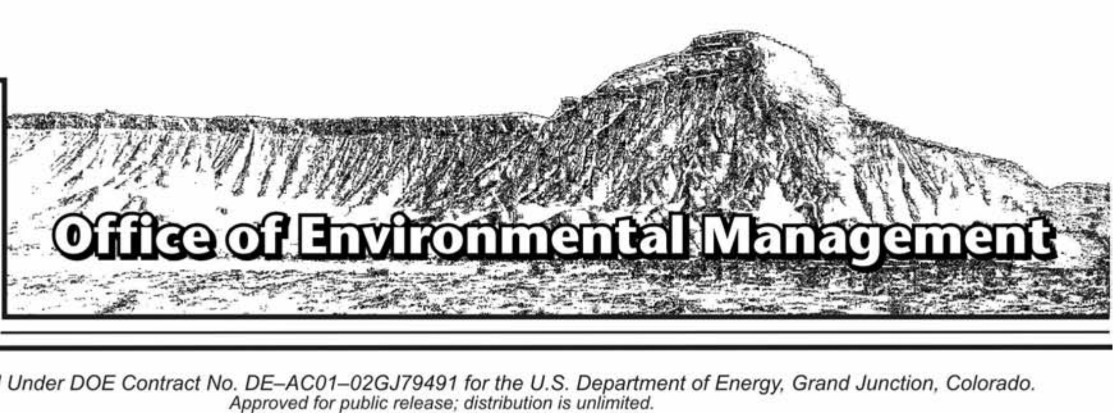
Hanford Geophysical Logging Project

Logging System Operating Procedures

January 2006



U.S. Department of Energy

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Revision 1

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Prepared for
U.S. Department of Energy
Office of Environmental Management
Grand Junction, Colorado

Prepared by
S.M. Stoller Corp.
Grand Junction, Colorado

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1.0 Introduction

In 1994, the U.S. Department of Energy (DOE) Richland Operations Office (DOE-RL) requested the DOE Grand Junction Office (DOE-GJO), Grand Junction, Colorado, to perform a baseline characterization of gamma-emitting radionuclides in the vadose zone beneath and around the single-shell tanks (SSTs) at the Hanford Site. To collect these measurements, Greenspan, Inc., of Houston, Texas, built three passive spectral gamma-ray logging system (SGLS) vehicles capable of acquiring spectral data from cased boreholes up to 600 feet (ft) deep employing high purity germanium (HPGe) detectors. Once the Hanford Tank Farms vadose zone baseline characterization was completed in fiscal year (FY) 2000, DOE-GJO was tasked by DOE-RL to perform a baseline characterization of gamma-emitting radionuclides in the vadose zone beneath and around the liquid waste disposal sites and burial grounds in the 200 Area Plateau at the Hanford Site.

1.1 Purpose

This logging procedure provides guidelines and instructions for conducting passive gamma-ray, high rate passive gamma-ray, directional passive gamma-ray, neutron moisture, passive neutron, and neutron capture logging activities on the Hanford Site. These procedures include descriptions of all vehicle components, their operation as a system, and data acquisition using HPGe and neutron moisture detectors.

1.2 Objective

This logging procedure ensures that quality data are collected by using approved procedures. These procedures include knowledge from lessons learned since acquiring the first SGLS spectra in FY 1995.

2.0 Logging System Fact Sheet

Truck Designation:	GAMMA 1 (γ1)	GAMMA 2 (γ2)	GAMMA 4 (γ4)
License Numbers:	E-37579 U.S. Govt.	E-37577 U.S. Govt.	E-37578 U.S. Govt.
V.I.N.:	1FDXK84E6RVA08340	1FDXF84E8RVA08338	1FDXK84EXRVA08339
Hanford ID No.:	HO-68B-3574	HO-68B-3572	HO-68B-3573
Vehicles:	1994 Ford F800, 6-cylinder turbo diesel, 6-speed manual transmission with a high-low range transfer case gearbox.		
Dimensions:	8 ft 4 in. wide, 24 ft 6 in. long, 11 ft 6 in. high (12 ft 2 in. high with rear lights up)		

Gross Vehicle Weight Rating (GVWR):	27,500 lbs
Gross Axle Weight Rating Front (GAWR FRT):	10,000 lbs
Gross Axle Weight Rating Rear (GAWR RR):	17,500 lbs
Gross Actual Load (12-19-97):	22,360 lbs
Gross Load Front (est.):	7,850 lbs
Gross Load Rear (est.):	14,510 lbs

Winch:	Greenspan, Inc.
Drum Size:	24.0-in. flange diameter, 24.8-in. barrel length, 14.3-in. barrel diameter
Cable Speed, Min/Max:	1 in. per minute to 30 feet per minute
Cable:	0.875-in.-diameter, 14-conductor, flexible steel tubing, Kevlar reinforced, polyurethane jacket.
Cable Length:	600 ft
Cable Breaking Strength:	5,000 lbs force
Cable Weight in Air:	34.8 lb/100 ft

Crane:	Ferrari S.p.a.
Model:	535 A-2
Serial Numbers:	18572 (γ1), 18573 (γ2), 18571 (γ4)
Weight Rating, Maximum:	3,197 lbs (1,450 kg)
Outreach:	21 ft (6.3 m)

Hydra-Gen®	Harrison Equipment Co., Inc.
Model:	HPU 15.0 MPC-160D
Power Output:	15 kVa
Phase:	Single phase, 120/240 Volts
Frequency:	60 Hertz, 62.5 Amps

Tungsten Shield:	
Weight:	35.25 lbs
Outside Diameter:	4.08 in.
Length and Thickness:	16.0 in. long and 0.30 in. thick
Composition:	90% Tungsten (W), 6% Nickel (Ni), 4% Copper (Cu)
KUTh Field Verifier:	AEA Technology QSA, Inc.
Serial Number:	118 (γ1), 082 (γ2), 115 (γ4)
Part Number:	188701
Source Strength:	2.453 μCi (1.662 μCi ^{40}K, 0.46 μCi ^{238}U, and 0.331 μCi ^{232}Th)
Composition:	11.7% potassium, 80 ppm ^{238}U, and 180 ppm ^{232}Th
Weight:	64 lbs
^{137}Cs Calibration Check-Source:	
Serial Number:	1013
Source Strength:	200 μCi
Composition:	Cesium-137
Weight (est.):	80 lbs
Neutron Calibration Standard:	CPN International, Inc.
Serial Numbers:	H380932510, H310700352, H340207279
Source Strength:	50 mCi
Composition:	Americium/Beryllium
Weight (est.):	20 lbs
Portable Fire Extinguishers:	
Instrument Cabin:	One, 15 lbs, Type BC, dry chemical
Driver's Cabin:	One, 2.5 lbs, Type ABC, dry chemical

3.0 Logging System Equipment Description

3.1 Logging System Vehicles

The SGLS vehicles are mounted on 1994 Ford F-800 truck chassis powered by FD-1460 diesel motors and are equipped with 6-speed manual transmissions, air brakes, and Marmon-Herrington all-wheel-drive (Figure 1-1). The spectral gamma-ray logging system is comprised of specialized electronic equipment housed in a separate instrument cabin that includes a personal computer and logging program capable of controlling all aspects of the logging process. To support the logging system the vehicles are also equipped with a hydraulic generator, hoist, crane, and liquid-nitrogen storage and dispensing system. For logging, spectroscopic amplifiers and multi-channel buffers are employed to process and record electronic pulses collected from various detectors. Enough logging cable is carried on each vehicle to log boreholes up to 600 ft deep.

3.2 Marmon-Herrington All-Wheel-Drive

In June of 1993, the truck chassis were modified from two-wheel to all-wheel-drive using kits manufactured by the Marmon-Herrington Co. of Louisville, Kentucky. A new front drive axle, transfer case, drivelines, shocks, and support assemblies were added to complete the conversion.

Air switches, located in the drivers cabin, are used to select the various power train combinations for driving and operating the SGLS (Figure 1-2). All-wheel-drive is selected using the two-position switch labeled “Front Axle.” A three-position shifter for the transfer case labeled “Trans Case” allows the driver to move the system between high, neutral, and low ranges. The power-take-off (PTO) gearbox is engaged using the two-position switch labeled “PTO.” Included with each switch are red pilot lights that illuminate when a switch is in the ON position. The combinations of these switches and how they affect the operation of the SGLS are presented in the table below.

Air-Switch Name	Normal Driving	All-Wheel-Driving	Data Acquisition
	Air-Switch Position		
Transfer Case	High	High or Low	Neutral
Front Axle	Off	On	Off
PTO	Off	Off	On

In addition, when the PTO is engaged, a red LED located on the Operations Console (Section 4.2) in the Instrument Cabin (Section 4.0) illuminates.

Figure 1. Logging System Vehicle

Figure 2. Air Switches and Vehicle Gauges

Owners' and operation manuals are on file at the field office for additional detail of the vehicle's equipment.

3.3 Hydraulic Systems

Hydraulic pressure is used to drive a generator, hoist, and crane, which support the logging operations and data acquisition process. Engaging the PTO initiates the hydraulic system. Mechanical power from the PTO drives a model 762 gearbox manufactured by Hub City. Attached to the gearbox are two hydraulic pumps. By design, the hydraulic pumps develop their optimal flow when the engine speed is operating between 1,100 and 1,400 revolutions per minute (RPM) or the "operating RPM." One pump is dedicated to the generator while the other pump supplies hydraulic pressure to both the hoist and crane. At operating RPM, the pumps generate the hydraulic force that provides mechanical power to the generator, hoist, and crane.

These systems consist of several components including pumps, motors, gearboxes, clutches, brakes, and fluid reservoirs. Hydraulic system maintenance is specified in the *Preventive Maintenance Procedure for the Spectral Gamma Logging System* (DOE 2005) and the *Hydraulic Maintenance Manual* (Greenspan).

A hydraulic pressure transducer, manufactured by Data Instruments, is affixed to the hoist and crane pump that relays the hydraulic pressure to a digital display located on the Operations Console (Section 4.2) and to the logging computer through the Sensor Panel (Section 4.3.8).

3.3.1 Harrison Equipment Co. Hydra-Gen® Generator System

Each SGLS is equipped with a 15-kilowatt (kW) hydraulic generator, or Hydra-Gen® manufactured by the Harrison Equipment Co. (Figure 1-3). This is the main generating source of alternating current (AC) for electrical systems operating on the vehicles.

Mechanical power is derived from a dedicated PTO-driven hydraulic pump, manufactured by Volvo, which supplies hydraulic pressure to a motor that rotates the generator. When the PTO is engaged and the engine speed is increased to operating RPM, the Hydra-Gen® produces 120-volt AC current at a frequency of 60 cycles (Hz). Two analog meters display the AC voltage and frequency from inside the instrument cabin.

The Hydra-Gen® is mounted under the vehicle on the outside of the frame in a vented compartment and is secured by a locking door. Included inside the compartment are the main circuit breaker box and the main power receptacle (Figure 1-3). These two devices are used to isolate the generator from the Power Distribution Panel (Section 4.1) and for connecting shore power directly to the vehicle. A special power cable and receptacle are needed if shore power is required. Shore power is not used during logging activities.

Figure 3. Harrison Hydra-Gen Generator System

The Hydra-Gen® is equipped with a small fluid reservoir filled with synthetic automatic transmission fluid (ATF) to lubricate the generator's moving parts. A thermometer and see-through liquid-level gauge are used to view the status of this reservoir. To cool the ATF, the Hydra-Gen® is equipped with a cooling fan and radiator assembly that are automatically actuated by thermostat control (Figure 1-3). A large reservoir, filled with synthetic AFT, is located under the back of the vehicle and supplies the pumps with hydraulic fluid for operation. These fluid levels need monitoring. The Hydra-Gen® is subject to the following constraints:

- The Hydra-Gen® will not operate if the PTO is not engaged.
- If the PTO is engaged but the engine speed is below operating RPM, the Hydra-Gen® will not produce sufficient power output to support the 120-volt AC systems.
- Shore power can be connected to the SGLS to operate the AC systems. Turn OFF the vehicle and the Power Distribution Panel circuit breakers. Turn OFF the main circuit breaker. Disconnect the power cable from the Hydra-Gen® at the main power receptacle and replace it with the special shore power cable. Turn ON the main circuit breaker.

Owners' manuals on file at the field office describe the Hydra-Gen® in more detail.

3.3.2 Hoist

Each SGLS is equipped with a custom-built two-speed hydraulic hoist (Figure 1-4) manufactured by Greenspan, Inc., of Houston, Texas. The hoist stores the logging cable on a spool assembly, conveys the logging sonde in and out of boreholes, and controls the rate of sonde movement. Stringent engineering design criteria were required for hoist speed. These requirements were that the rate of sonde movement achieves accurate and repeatable speeds between 1 inch per minute (in./min) and 30 feet per minute (ft/min).

Hydraulic power for the hoist is derived from a PTO-driven, variable-speed, Sundstrand series 90 pump and Sundstrand series 51 motor, which rotates a model 763 gearbox manufactured by Hub City (Figure 1-4). To achieve design speed, gear ratios are adjusted using two gear reducing gearboxes manufactured by SEW Eurodrive. Depending upon the desired hoist speed, each gear reducer can rotate a separate hydraulic clutch. When engaged, a clutch's power is supplied to a second model 763 gearbox, which is attached by a heavy-duty chain to the spool assembly. Hoist speed is controlled by solenoids that adjust fluid volume inside the variable-speed series 90 pump.

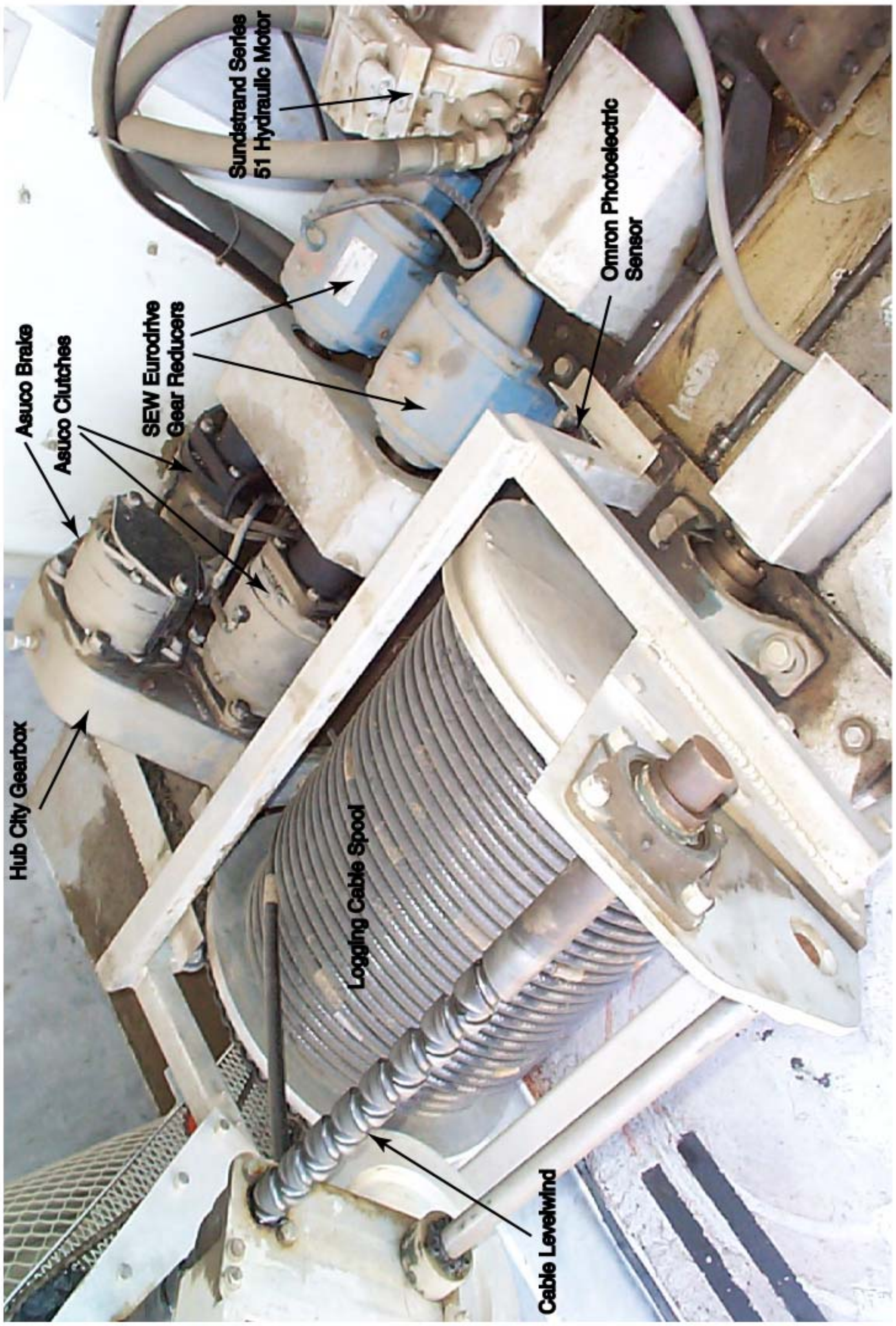

Figure 4. Hydraulic Hoist System Components

Failsafe braking (hydraulic pressure to release) is actuated when insufficient hydraulic pressure is present to release springs inside a brake unit manufactured by Asuco (Figure 1-4). The hydraulic brake is affixed to the gearbox driving the spool assembly. The brake can be actuated manually from the instrument cabin, automatically by a photoelectric sensor, or by computer control.

The photoelectric sensor, manufactured by Omron, is located between the hoist frame and drum (Figure 1-4). This is a safety device that alerts the logging program when a cable overwrap condition occurs. During logging operations, if the logging cable breaks the plane of the sensor the logging program automatically applies the hoist brake and interrupts logging. Before logging can resume, the cable wrap has to be checked, corrected if necessary, and the hoist brake reset.

Trained personnel can manually operate the hoist and hoist brake from the Operations Console in the Instrument Cabin. The hoist and hoist brake are subject to the following constraints:

- The hoist will not operate if the PTO is not engaged or if the motor is OFF.
- The hoist will not operate if the PTO is engaged but the "Sensor" and "Console" DC circuit breakers are OFF.
- If the PTO is engaged and the logging computer is ON but the engine speed is below operating RPM, the hoist will operate very slowly.
- The hoist brake can be applied at any time during logging operations. To release the brake and resume logging, the hoist brake must be cycled twice as follows, ON-OFF-ON-OFF.
- **NOTE:** The hoist brake should always be ON when not logging to prevent the sonde from spooling into the sheave wheel.

Technical specifications for the hoist components are on file at the field office.

3.3.3 Ferrari Crane

Each vehicle is equipped with an articulated 3-piece crane with two extensions manufactured by Ferrari S.p.a., Italy (Figure 1-1). Fully extended, the crane's hydraulic outreach is almost 21 ft (6.3 meters). When logging, the crane is used to align and support the sheave wheel, logging cable, and sonde over the borehole (Figure 1-5). For mobility, the crane is stowed in a folded position. Ground stabilizers (outriggers) are deployed to level the crane while two poles supply support for the end of the crane during logging operation.

Figure 5. Sheave Wheel, Logging Cable, and Crane Supports

Hydraulic power for the crane is derived from the PTO-driven Sundstrand series 90, variable-speed pump. This pump also provides the hydraulic pressure to the hoist. A lever at the base of the crane column selects the crane's two control modes (Figure 1-6).

- Manual Mode: Switch the lever toward the crane (right hand). This is the normal position for the crane's control mode.

- Remote Pendant: Switch the lever away from the crane (left hand). The remote pendant control is currently disabled.

The crane is controlled in manual mode by five levers located on the side Distributor Panel (Figure 1-6). Each lever performs a specific function to rotate, extend, and contract the rams and extensions. Color-coded handles, symbols, and arrows indicate the movement and direction each lever controls.

The crane is subject to the following constraints:

- The crane will not function if the crane is extended and the PTO is not engaged.

- If the crane is extended and the PTO is engaged but the engine speed is below operating RPM, the crane will move very slowly.

- If the motor is OFF and the crane is extended, the hydraulic fluid in the supply lines will slowly bleed back into the fluid reservoir but the crane will not suddenly fall.

Operators' and parts manuals for the Ferrari crane are on file at the field office.

3.4 Liquid Nitrogen Storage and Dispensing System

Caution: LIQUID NITROGEN (LN_2) can cause severe frostbite (boiling point -320 °F) and asphyxiation by displacing air. A Material Safety Data Sheet describing hazards associated with LN_2 is presented in Chapter 11.0. A Shipping Document is required to be carried and made available by the driver whenever LN_2 is stored or shipped on the logging vehicles. This document is carried in the driver's cabin.

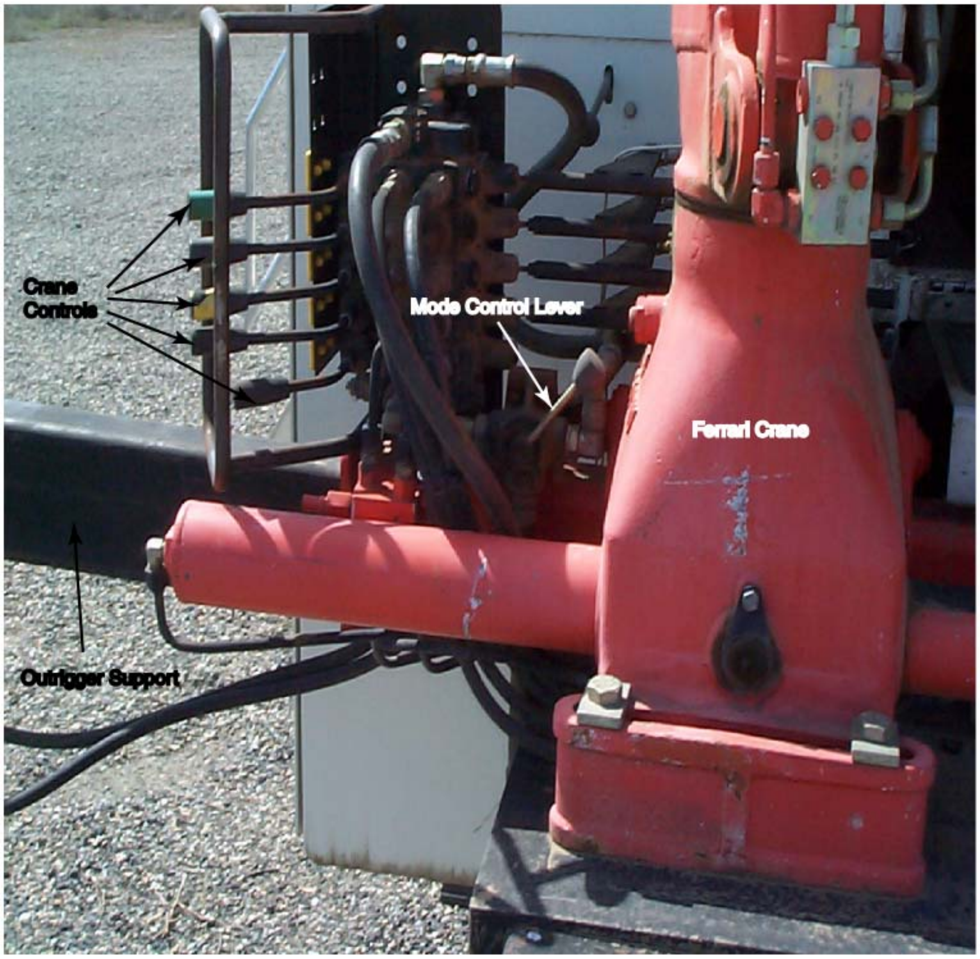

Figure 6. Ferrari Crane Controls

Each SGLS is equipped with a LN_2 storage vessel or dewar that is located inside the hoist compartment and permanently affixed to the compartment's structural frame (Figure 1-7). These are standard size commercial dewars capable of holding approximately 180 lbs. of cryogenic fluid at low pressures. The LN_2 stored in these dewars vents continuously through a 22 lb. per square inch (PSI) pressure relief valve. Dewars are equipped with various gauges, valves, and connections to safely transfer and dispense LN_2, including the following components:

- Liquid-level gauge
- Pressure gauge
- 22-PSI pressure relief valve
- Vent ball valve - connector combination
- Liquid ball valve - connector combination

The LN_2 dispensing system or auto-fill consists of a timer, solenoid valve, liquid valve, sonde connector, copper tubing, and a cryogenic hose (Figure 1-7). The auto-fill is used to fill the dewars carried on the high-purity germanium (HPGe) detectors with LN_2 in the field. During logging activities, the LN_2 is vented to the atmosphere through the logging cable and the exhaust flow is monitored in the Instrument Cabin (Section 4.0).

A hydraulically controlled tray is located on the outside of the hoist compartment near the dewar where two logging tools or sondes can be carried and stored in a vertical position (Figure 1-8). The tray is accessible through a secured door from outside the vehicle. The tray is raised and lowered by using a lever located by the crane.

A multifunctional timer, located inside the hoist compartment, is used to activate the auto-fill system and set the cycle interval (time between fills). Connect the cryogenic hose to the sonde (hose/sonde connector), open the liquid ball valve, and activate the timer. This opens the solenoid valve and copper tubing carries the low pressure LN_2 to the sonde. As the sonde fills, exhaust gas is vented through an electrical sensor located on the hose/sonde connector. The auto-fill turns itself OFF when the sensor detects LN_2. The timer will continue to activate and cycle the auto-fill until it is switched OFF. A dewar normally has to be cycled every 8 hours to keep the HPGe detector cold; it takes from 12 to 20 minutes to fill an HPGe dewar.
Dewars carried on the vehicles have to be refilled from supply dewars. To transfer LN_2, follow the *Liquid Nitrogen Transfer Procedure* presented in Chapter 11.0.

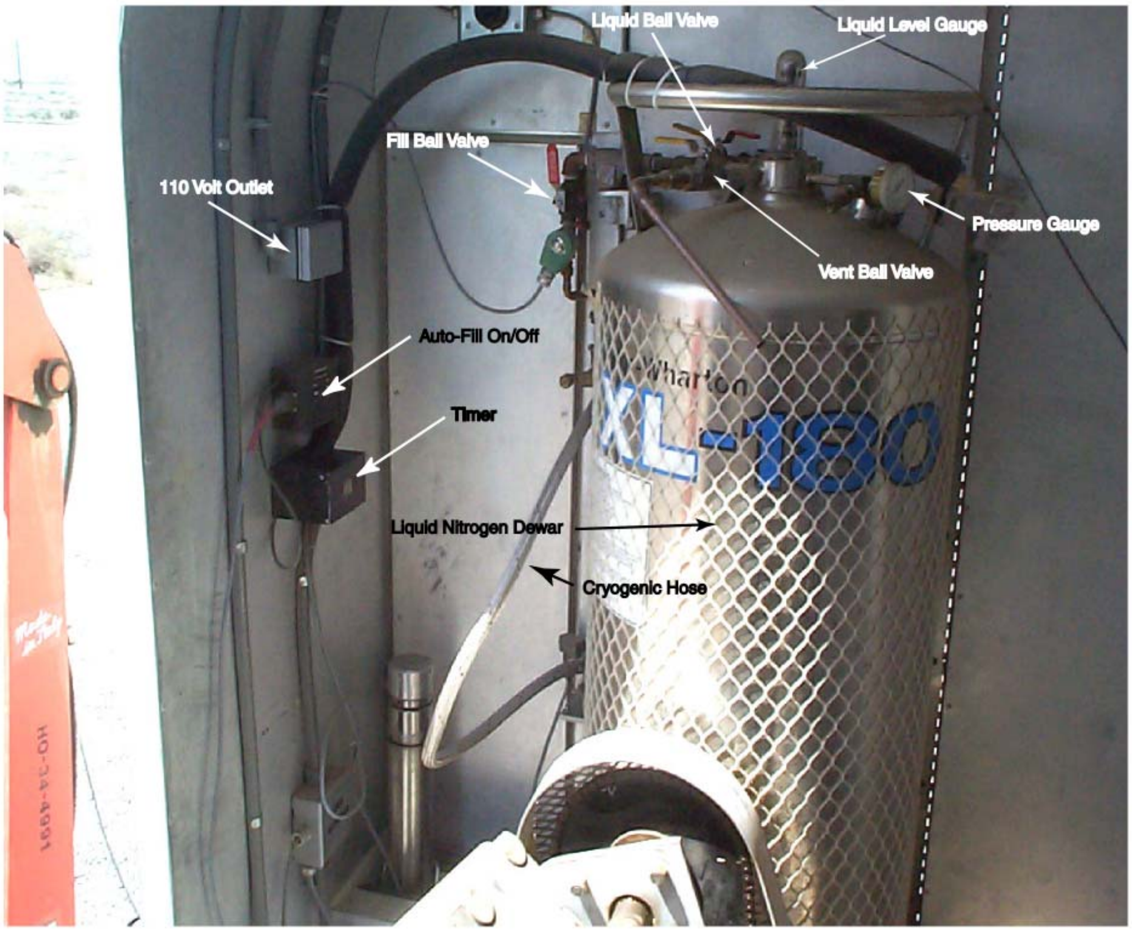

Figure 7. Liquid Nitrogen Storage and Distribution System

Figure 8. Sonde Trays and Liquid Nitrogen Dewar Access

4.0 Instrument Cabin

The Instrument Cabin is the control center for conducting logging operations (Figure 1-1). From the instrument cabin, trained personnel perform all aspects of the data collection process including set up, operation, and monitoring. The following components inside the Instrument Cabin are used to control the logging process (Figure 1-9).

- Power Distribution Panel
- Operations Console
- Instrument Equipment Rack
- Support Equipment

As-built schematics for these components are described in the *Bill of Material* (Greenspan).

4.1 Power Distribution Panel

Sixteen circuit breakers control the power distribution for the various AC and DC electrical systems operating on the SGLSs. These circuit breakers are located on the "Power Distribution Panel" affixed to the wall inside the instrument cabin (Figure 1-10). Each breaker is labeled to identify which circuit it controls along with an amperage rating to identify the size of the breaker. AC and DC circuits are separated into two columns: AC circuits are on the left and DC circuits are on the right. The circuits are as follows:

AC Circuits	DC Circuits
• Computer	• Sensor
• Wall-1	• Console
• Air Conditioner	• Telephone
• Wall-2	• HEPA Filter
• Internal Lights	• Heater Fan
• Back Lights	• Step Lights
• Drum Lights	• Drum Light
• Vacuum	• Dome Light

Figure 9. Instrument Cab

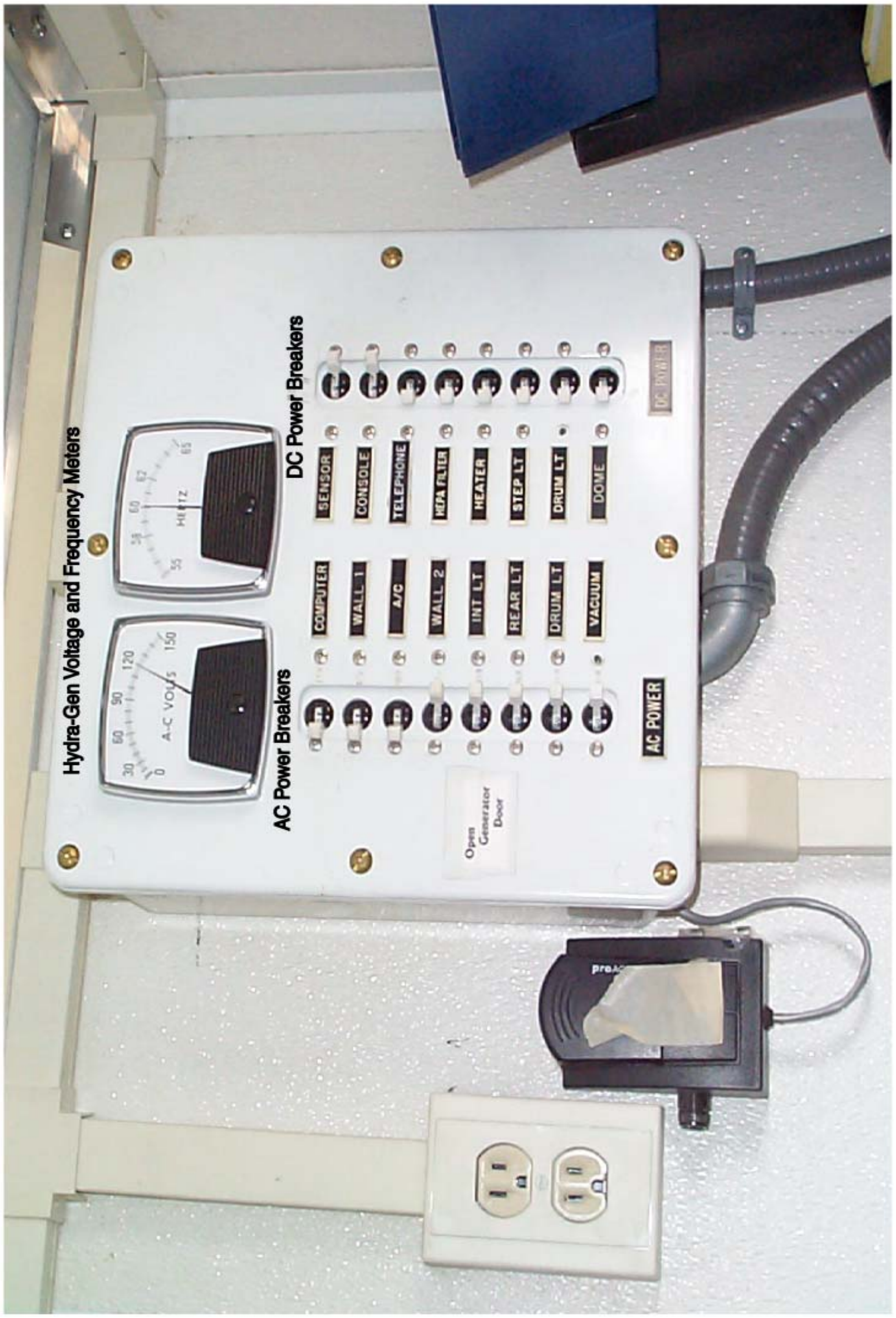

Figure 10. Power Distribution Panel

A voltage and frequency meter, located at the top of the Power Distribution Panel, shows the power output of the Hydra-Gen®.

The logging system has a specific "Power Up, Power Down Sequence" that is outlined in Chapter 4.0. The order in which the circuit breakers are turned ON and OFF can affect supporting systems and can damage electrical circuitry if done out of sequence.

4.2 Operations Console

The Operations Console (OC) represents the control interface where trained personnel control and monitor the various operations affecting the vehicle and hoist (Figure 1-11).

DC power is supplied to the OC by the circuit breaker labeled "Console" on the Power Distribution Panel. When the Console circuit breaker is ON, two red LEDs illuminate, which are located on the OC and Sensor Panel (Section 4.3.8) labeled "Console" and "DC Power," respectively.

The following components are located on the OC, which are grouped together under headings indicating their main function.

Power

- Red LED labeled *Console*

Remote Engine Operation and Monitoring

- Diesel Fuel Level Gauge
- Engine Coolant Temperature Gauge
- Engine Oil Pressure Gauge
- Remote Ignition Key
- Tachometer Gauge
- Engine Throttle Knob
- *Manual/Automatic* Shutdown Toggle Switch
- Red *Computer* LED
- Red *PTO* LED

Figure 11. Operations Console

Hoist Operation and Monitoring

- Hoist Control Handle
- Hoist Brake Button
- Red Hoist *Brake* LED
- *Manual/Computer* Hoist Toggle Switch
- Hoist Control Mode LEDs
- Hydraulic Fluid Pressure Digital Display
- Weight Digital Display
- Depth Digital Display
- Liquid Nitrogen Flow Meter

4.2.1 Remote Engine Operation and Monitoring

During logging operations users can monitor and operate the vehicle's engine from the OC. Remote vehicle operation and monitoring is an important safety feature. With the PTO engaged, the red LED labeled "PTO" illuminates on the OC.

4.2.1.1 Fuel, Oil Pressure, and Temperature Engine Gauges

Basic engine status can be monitored from the OC using the gauges listed below. These are standard motor vehicle gauges and should be monitored during logging operations for normal and/or off-normal conditions.

- Diesel Fuel Level Gauge
- Engine Coolant Temperature Gauge
- Engine Oil Pressure Gauge

Engine operating parameters are relayed to the OC and Computer Automated Spectral Acquisition System II (CASASII) LOG program (Section 7.1) through the Sensor Panel (Section 4.3.8) for monitoring.

4.2.1.2 Remote Ignition Key

The remote ignition key can be used to start and stop the vehicle engine.

4.2.1.3 Tachometer Gauge and Engine Throttle Knob

From the OC, a tachometer gauge and multi-functional throttle knob control the vehicle's engine speed (Figure 1-11). The tachometer displays the vehicle engine speed in units of RPM and the throttle knob increases or decreases the engine's speed. The remote throttle control is connected directly to the engine; consequently, engine speed can be adjusted independently of the vehicles configuration from this control.

To increase or decrease engine speed, the throttle is twisted clock- or counter-clockwise. The throttle is designed to stay in place by friction-resistance when the desired RPM is reached. To release the throttle back to idle a large spring-loaded button is depressed on top of the throttle body. When depressed, the engine speed immediately drops down to an idle.

Minimum operating speed for data acquisition is 1,100 RPM, which can be maintained by manipulating the throttle and observing the response of the tachometer. After logging is completed, the throttle is released to idle.

4.2.1.4 Shutdown Toggle Switch - Manual/Automatic

Select *Manual* engine shutdown mode. The *Automatic* operating mode is not currently used.

4.2.2 Hoist Operation and Monitoring

Hoist functions can be manipulated and monitored from the OC using a control handle, brake knob, digital displays, and red LEDs (Figure 1-14). During logging, the CASASII LOG program controls the hoist function.

4.2.2.1 Hoist Control Handle

A multi-directional control handle or joystick labeled “Hoist Control” is used for operating the hoist (Figure 1-11). Three functions are performed with the control handle including reeling ON and/or OFF logging cable and engaging the high-speed (30 ft/min) side of the hoist. High-speed is engaged by depressing the small red button on top of the joystick and terminated when the button is released. The functionality of the hoist is described in Section 3.3.2.

During logging, the CASASII LOG program controls the hoist function. Hoist movement is signaled to the logging computer through the Sensor Panel from the depth encoder, weight, and hydraulic pressure sensors.

4.2.2.2 Hoist Brake

A large red knob on the OC is the hoist brake (Figure 1-11). To apply the brake, depress the knob until it locks in place and a red LED labeled “Brake” above the knob illuminates. Twisting the knob releases the brake. The functionality of the hoist brake is described in Section 3.3.2.

During logging, the CASASII LOG program controls the hoist brake. If a hoist problem is sensed, such as an overwrap or snag, the CASASII LOG program will signal an alarm through the Sensor Panel and apply the hoist brake.

The hoist brake should always be ON when the vehicle is set up and standing by to begin logging. This will prevent the hoist from accidentally moving and avoid a cable warp condition.

4.2.2.3 Hoist Toggle Switch - Computer/Manual

The hoist operates in either *Computer* or *Manual* mode; select *Computer* mode (Figure 1-11). In *Computer* mode, the CASASII LOG program is in control of the hoist and a red LED labeled "Computer" illuminates on the OC. The joystick also operates under *Computer* mode.

In *Manual* mode, the remote pendant is used to move the hoist. *Manual* mode is currently disabled; consequently, *Computer* mode is the only method to reel ON and/or OFF logging cable.

4.2.2.4 Hydraulic Fluid Pressure

A digital display, labeled "Hydraulic," shows the hydraulic fluid pressure in pounds per square inch (PSI) in the PTO-driven pump that powers the hoist and crane (Section 3.3.2) (Figure 1-11). A hydraulic pressure transducer relays the hydraulic pressure to the OC and CASASII LOG program through the Sensor Panel. Hydraulic pump pressure varies during logging and should be monitored during logging operations.

4.2.2.5 Weight Display

A digital display labeled "Weight" shows the weight in pounds being exerted on the logging cable (Figure 1-11). A load cell between the crane and sheave wheel (Figure 1-5) relays the weight to the OC and CASASII LOG program through the Sensor Panel. Too much weight will invoke the hoist brake by the CASASII LOG program and interrupt logging. The hardware and alarm limit data file is set up to invoke the hoist brake if the load sensor exceeds 3,000 lbs.

A glass fuse is located on the Sensor Panel, labeled "Load Pin," as an electrical safety device for this circuit.

4.2.2.6 Depth Display

A digital event counter labeled "Depth," manufactured by Vorne Industries, displays sonde depth (Figure 1-11). An optical sensor on the sheave wheel assembly counts electronic pulses as the sheave wheel turns (Figure 1-5). The counts are scaled and displayed as depth in real time in units of feet. Data signals are sent to the OC and CASASII LOG computer through the Sensor Panel. To reset depth to "0.00 ft" a button on the display's faceplate is depressed that clears the last value displayed.

A glass fuse is located on the Sensor Panel, labeled "Encoder," as an electrical safety device for this circuit.

4.2.3 Liquid Nitrogen Flow Meter

A digital display labeled "Nitrogen" is used to monitor the exhaust flow of LN_2 (Figure 11). LN_2 is monitored when spectral gamma-ray data are acquired using high-purity germanium (HPGe) detectors. To measure LN_2 flow, a model 100-7 Flo-Sensor, manufactured by McMillan Co., is located inside the OC. Once measured, the LN_2 is <u>safely</u> vented to the atmosphere through the wall of the instrument cabin. The Flo-Sensor is capable of measuring LN_2 flows ranging between 400 – 2,000 milliliters per minute (ml/min) and sending data in real time to the OC and CASASII LOG program through the Sensor Panel.

The "Nitrogen" display on the OC conveys the general operating condition of the sonde. The following LN_2 flow scenarios can affect data acquisition:

- Normal range for LN_2 flow is between 600 and 1,400 ml/min depending upon which HPGe detector is used.
- Between 8 and 12 hours is a maximum operating time for a dewar. For a detector to continue operating, the LN_2 has to be replenished within this time.
- If LN_2 flow drops from normal range to 00.0 ml/min, the detector will stop operating in approximately 30 minutes if the LN_2 is not replenished. A temperature-sensing element attached to the detector will automatically reduce the bias supply voltage to zero, effectively shutting OFF the detector, when the detector begins to warm up.
- If LN_2 flow is greater than 1,700 ml/min, the detector's bias supply voltage won't turn ON. A high flow indicates that the LN_2 has not had enough time to stabilize the low temperature-sensing element on the monitoring circuit. Approximately 6 to 8 hours is needed to stabilize HPGe detectors for use if they have been stored at room temperature.
- If LN_2 flow remains high and/or won't stabilize, even after 6 hours, a faulty dewar on the sonde is indicated.

4.3 Instrument Equipment Rack

An equipment rack located in the instrument cabin holds the various components of the logging system (Figure 1-12). A generalized diagram of the logging system is presented in Figure 1-13. Components in the equipment rack include:

- Logging Computer and Monitor
- EG&G Ortec Model 4001C Modular System Bin
- EG&G Ortec Model 672 Spectroscopy Amplifier
- EG&G Ortec Model 921 *Spectrum Master* High-Rate Multichannel Buffer
- EG&G Ortec Model 973 Spectroscopy Amplifier
- EG&G Ortec Model 918 Dual Port Fanout
- Signal Monitor Panel
- Sensor Panel

4.3.1 Logging Computer and Monitor

A personal computer (PC) and monitor are used to operate the *Computer Automated Spectral Acquisition System II* (CASASII) LOG program (Section 7.1) and store the acquired data on a hard disk (Figure 1-14). For an operating system, the PC utilizes Microsoft Windows® 95. Other hardware systems interfaced to the PC include hoist control, vehicle status monitoring, and data acquisition via a Signal Monitor Panel (Section 4.3.7) and Sensor Panel (Section 4.3.8).

4.3.2 EG&G Ortec Model 4001C Modular System Bin

The Model 4001C Modular System Bin (NIM Bin) is a device capable of holding up to 12 interchangeable modules while simultaneously distributing AC and DC power through a common bus bar (Figures 13 and 15). All components of the modular system are built in accordance with *Standard NIM Instrumentation System* Report DOE/ER-0457T. This standard dictates the size of the modules, power tolerances, type, and location of connectors. A small control panel is located at the right side of the NIM Bin with the following control functions:

- An ON/OFF switch controls power input to the NIM Bin module.
- When the power switch is ON an amber color pilot lamp illuminates.
- Test Jacks are provided for checking power supply voltages across the bus bar.

AC power to the NIM Bin module is supplied through the Uninterruptible Power Supply (UPS) (Section 4.5), which is controlled by the circuit breaker labeled “Computer” on the Power Distribution Panel. Power to the detector is supplied through the logging cable via the NIM Bin module so a Power Up, Power Down Procedure (Chapter 4.0) is followed to avoid damage to their sensitive electrical circuitry.

Figure 12. Instrument Equipment Rack and Operations Console

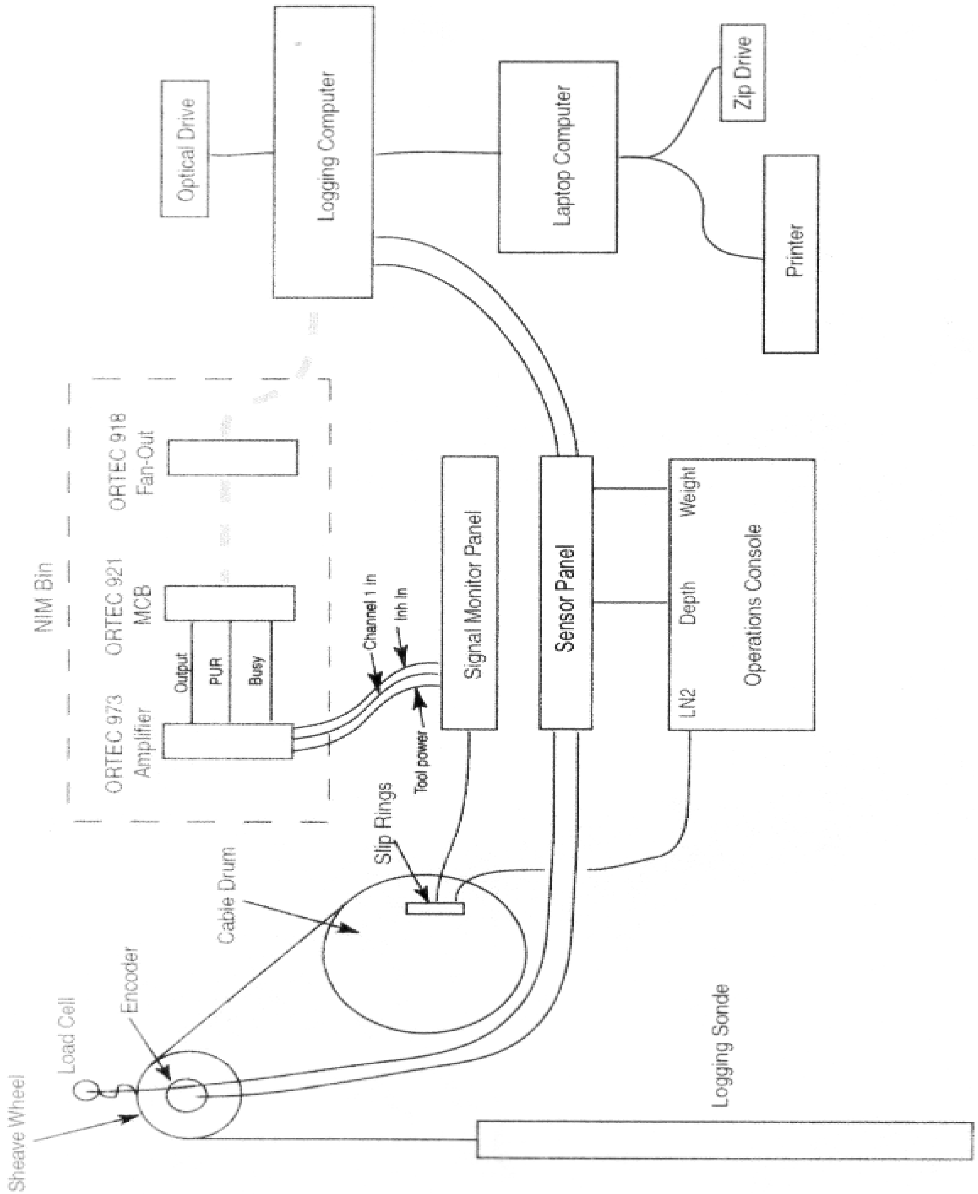

Figure 13. Generalized Diagram of the Logging System Configuration

Figure 14. Instrument Equipment Rack

The NIM Bin module's power should always be OFF when a sonde is being connected or disconnected from the logging cable. Operate the NIM Bin module as follows when AC input power is ON.

- Turn ON the NIM Bin module's power switch after connecting the logging cable and sonde.
- Turn OFF the NIM Bin module's power switch before disconnecting the logging cable and sonde.

The Model 4001C Modular System Bin operating and service manual is on file at the field office.

4.3.3 EG&G Ortec Model 921 *Spectrum Master* High-Rate Multichannel Buffer (MCB)

The Model 921-MCB is an instrument that collects output signals from a spectroscopy amplifier, performs pulse-height-analysis (PHA) on those signals, and displays the results in real time on the PC's monitor as spectra. The MCB is a multi-functional instrument that is the heart of the data acquisition system (Figures 1-13 and 1-15). The MCB emulates the function of a multichannel analyzer, analog to digital converter, and a pulse-height-analyzer independently of PC operation.

Two MCBs are located in each vehicle; these are doublewide modules and have dedicated spectroscopy amplifiers. During logging, the MCBs control the signal acquisition, while the CASASII LOG program controls the hardware to move the sonde, record the data, and monitor the vehicle.

Configuration of a MCB is through a specialized computer program written by EG&G Ortec named MAESTRO II. This program is used to set up the gain stabilization feature of the 921-MCB. MAESTRO II is located on a directory named MCA on the logging computer's hard drive but will not be explained further in this document.

The Model 921 Spectrum Master operating and service manual is on file at the field office.

Figure 15. Instrument Rack Components

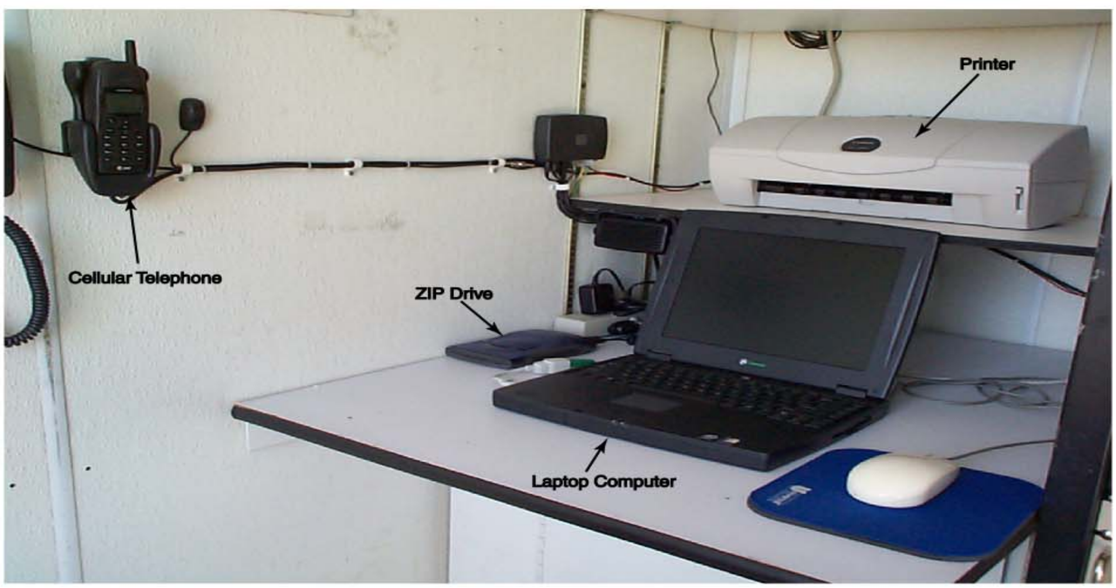

Figure 16. Instrument Cabin Work Area

4.3.4 EG&G Ortec Model 672 Spectroscopy Amplifier

The Model 672 spectroscopy amplifier accepts input signals from a detector preamplifier and provides output signals suitable for use with the MCB (Figures 1-13 and 1-15). This amplifier is employed when either the neutron moisture gauge, passive neutron, or sodium iodine (NaI) sondes are used for logging.

This is a doublewide module located in the NIM Bin. Configuration, controls, and indicators regarding the application of this module are discussed in the Neutron Moisture Gauge Logging Procedure (Chapter 7.0).

The Model 672 spectroscopy amplifier operating and service manual is on file at the field office.

4.3.5 EG&G Ortec Model 973 Spectroscopy Amplifier

The Model 973 spectroscopy amplifier accepts input signals from a detector preamplifier and provides output signals suitable for use with the MCB (Figures 1-13 and 1-15). The logging system employs this singlewide amplifier when HPGe sondes are used for logging. Configuration, controls, and indicators regarding the application of this module are discussed in the SGLS and HRLS Logging Procedures, Chapters 5.0 and 6.0, respectively.

The Model 973 spectroscopy amplifier operating and service manual is on file at the field office.

4.3.6 EG&G Ortec Model 918 Fanout

The model 918 Fanout is an electronic signal splitter (Figures 1-13 and 1-15). This doublewide instrument allows either one or both MCBs to communicate with the logging computer without physically changing any modules in the NIM Bin. Both MCBs are connected to the Fanout with one ribbon cable each and one ribbon cable from the Fanout is connected directly to the logging computer. There is no set up for the Fanout because it possesses only hardware connections. The different MCBs are selected when Log Initialization is set up using the CASASII LOG program (Section 7.1).

4.3.7 Signal Monitor Panel

A Signal Monitor Panel is located in the equipment rack to indicate if data signals are being conveyed from the sonde to the spectroscopy amplifiers during logging (Figure 1-15). The signal monitor panel is used as an interface between the sonde and the modules in the NIM Bin. DC power to the Signal Monitor Panel is supplied by the circuit breaker labeled “Sensor” on the Power Distribution Panel.

The panel consists of two sets of side-by-side toggle switches and red LED pilot lights. The labels “HV1” and “HV2” distinguish each toggle switch. HV is an abbreviation for “high voltage” and represents the HV bias supply carried on the detector’ wiring harness. Currently, only HV1 toggle switch is used. Signal monitor scenarios are discussed below that can affect logging.

- Switch HV1 ON only after the logging cable and sonde are attached or circuitry on the detector can be damaged. Follow the Power Up, Power Down Sequence in Chapter 4.0.

- If HV1 is ON, then the corresponding red LED should illuminate when operating under normal circumstances.

- If HV1 is ON, without a corresponding red light, then no data signals are being sent from the detector and may require repair or indicate a warm tool.

Other red LEDs, labeled +24V, -24V, +12V, and –12V, are included on the Signal Monitor Panel that indicate the condition of the power signal between the NIM Bin and sonde (Figure 1-15).

4.3.8 Sensor Panel

A Sensor Panel is located at the bottom of the equipment rack where the various signal and sensor wiring harnesses converge so their real time data can be conveyed to the CASASII LOG program for monitoring and control (Figure 1-12). These various data signals include the vehicle status, hoist, signal monitor panel, LN_2 flow, weight, depth, data acquisition system, and other electronic sensors. The Sensor Panel is completely enclosed and secured in the equipment rack and requires no set up.

Two red LEDs, labeled “AC Power” and “DC Power,” are located on the faceplate of the Sensor Panel. When the AC breaker switch labeled “Computer” on the Power Distribution Panel and the NIM Bin power switch are ON, the red “AC Power” LED illuminates. When the DC breaker switches labeled “Sensor” and “Console” on the Power Distribution Panel are ON, the red “DC Power” LED illuminates.

Three glass fuses, labeled “Horn,” “Load Pin,” and “Encoder” are located on the faceplate of the Sensor Panel as electrical safety devices for these circuits.

4.4 Instrument Cabin Work Area

Inside the instrument cabin is a work area for the operator to sit, perform simple analysis, operate the hoist, and monitor logging activities. The following office items are located in the work area (Figure 1-16).

- Laptop Computer
- Zip Drive
- Printer

4.4.1 Laptop Computer

A laptop computer is located in the work area. The laptop is networked to the logging computer and is used to analyze verification spectra and data, control printing, and transfer data files to the zip drive.

4.4.2 Zip Drive

Data files are transferred from the PC's hard drive to a zip drive (Figure 1-16). The zip disk is conveyed to the office where the data are transferred to the server for storage.

4.4.3 Printer

A color printer is attached to the laptop computer so preliminary field data can be printed after being analyzed (Figure 1-16). This is a small color printer for use in the field; normal and standard operating practices will be used and will not be explained in this document.

4.5 Uninterruptible Power Supply (UPS)

A UPS is secured to the instrument cabin floor on the right side of the equipment rack (Figure 1-17). AC power to the UPS is supplied by the circuit breaker labeled "Computer" on the Power Distribution Panel. The UPS is an integrated device that provides both on-line voltage regulation and on-line battery recovery for the data acquisition system. Components affected by the UPS include the logging computer and monitor, NIM Bin module, sonde, and AC circuitry supported through the Signal Monitor and Sensor Panels.

An enable switch is located on back of the UPS that puts the unit in service and is left ON at all times. A pushbutton on the faceplate labeled "Test" is used to energize the UPS. Below the Test button is a second unlabeled button, which turns OFF the UPS after logging is finished. The UPS performs an internal system check when first energized and recharges the battery pack automatically by special circuitry when the UPS is energized. Two green-segmented LEDs graphically display the power output and available battery capacity.

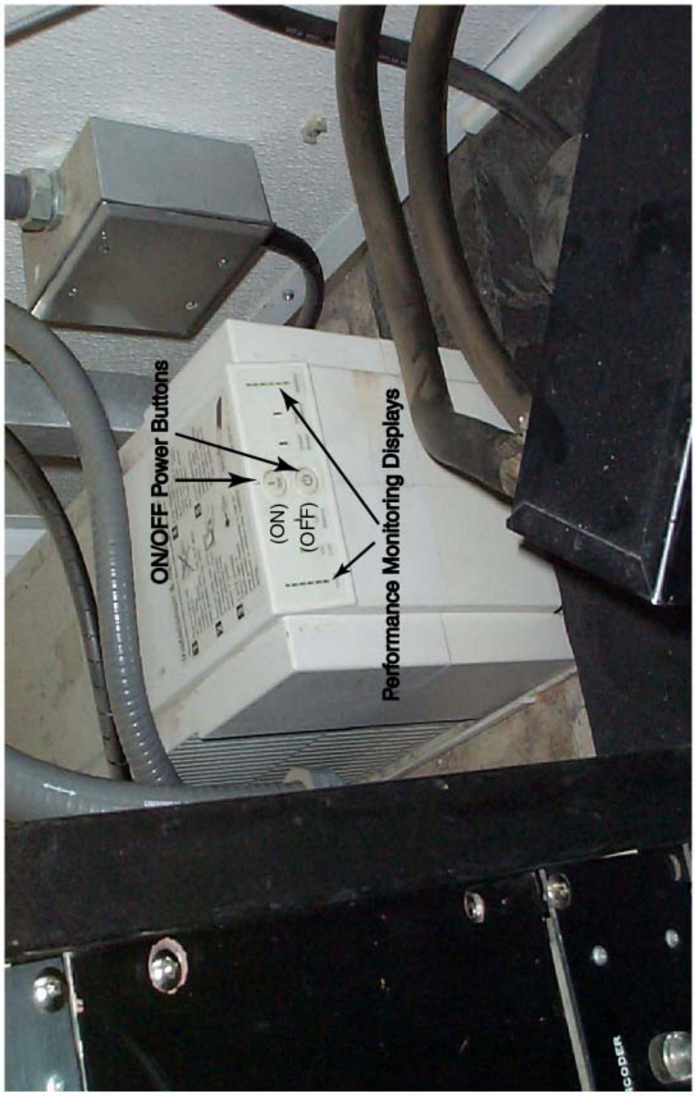

Figure 17. Uninterruptible Power Supply (UPS)

If AC power is disrupted, the UPS automatically transfers to on-line battery recovery in less than two milliseconds. Typically, on-line battery power will support electrical loads for 20 minutes or less. An audible alarm will beep for about 2 minutes before the low battery shut down occurs and the UPS turns OFF.

When distances between boreholes are short and equipment storage and set up can be accomplished in less than 20 minutes, the UPS can be kept ON to supply power to the data acquisition system (turn OFF the monitor). The UPS recovers automatically and switches to on-line voltage regulation when the Hydra-Gen® is brought back on-line.

4.6 Air Conditioner

An air conditioner/heating unit is mounted on the wall of the Instrument Cabin. AC power is supplied by the circuit breaker labeled "Air Conditioner" on the Power Distribution Panel. A control panel regulates the fan speed and selects between fan, heating, or cooling modes. This unit is used to heat and cool the work area and does not affect the operation of the electronic modules in the equipment rack. This is a standard air conditioner; therefore, normal operating procedures will be followed and will not be explained in this document.

4.7 Smoke and CO Alarm

Each vehicle is equipped with one smoke/CO alarm attached to the wall of the instrument cabin. This alarm is powered by a 9-volt battery.

The alarm should be tested on a regular basis (weekly) by pressing the test button on the cover. The alarm should chirp once. Then the battery (green) and service (yellow) lights will flash. Next the smoke alarm should flash and the horn should beep three times twice. Finally the CO symbol should flash and the horn should beep four times twice.

The smoke alarm Owner's Manual is on file at the field office.

4.8 Portable Fire Extinguishers

One 15-lb, B-C rated, dry-chemical portable fire extinguisher is located in the Instrument Cabin and secured to the floor with a permanent fixture. A second, 2.5-lb, ABC rated, dry-chemical portable fire extinguisher is carried in the driver's cabin as required by U. S. Department of Transportation (DOT) regulation.

Stoller will ensure that the fire extinguishers meet the portable fire extinguisher inspection, testing, and maintenance program outlined in the *Hanford Fire Protection System Testing/Inspection and Maintenance Procedure* (HNF-PRO-351). An inspection tag that is affixed to the fire extinguishers will be completed at monthly inspections.

Access to the fire extinguisher should not be blocked with equipment and/or stored materials. Applying good housekeeping practices in the instrument cabin allows access to the fire extinguisher at all times.

5.0 Detectors

Various types of detectors can operate from each SGLS. An individual detector and housing together comprise a logging tool or sonde. Detectors are listed below.

- HPGe Detector
- Planar HPGe Detector
- Neutron Moisture Gauge
- Passive Neutron Detector
- Neutron Capture Detector
- Directional HPGe Detector

Information for the detectors is on file at the Stoller office.

5.1 HPGe Detector

Stoller is the DOE qualified custodian of passive gamma ray, p-type HPGe detectors manufactured by EG&G Ortec. Each detector is capable of recording gamma-ray spectra while operating in medium to low intensity gamma-ray fluxes up to 8,000 pCi/g cesium-137 (^{137}Cs). LN_2 is required to keep these detectors at their operational design. These detectors were used extensively during the FY 1995-2000 Hanford Vadose Zone Baseline Characterization Project conducted in the 200 East/West Tank Farms.

When these detectors are employed with one of the logging vehicles, they comprise the Spectral Gamma-Ray Logging System (SGLS). SGLS logging procedures are presented as Chapter 5.0.

5.2 Planar HPGe Detector

Stoller is the DOE qualified custodian of a low-efficiency, passive gamma ray, n-type planar HPGe detector. This detector is capable of recording gamma-ray spectra while operating in intense gamma-ray fluxes up to 100 million pCi/g ^{137}Cs. The detector is a 6-mm by 8-mm, planar HPGe model number IGLET-06XXX-S manufactured by EG&G Ortec.

When this detector is employed with Gamma 1, it is referred to as the High Rate Logging System (HRLS). HRLS logging procedures are presented as Chapter 6.0.

5.3 Neutron Moisture Gauge

Stoller uses a nuclear soil moisture gauge that is neutron-activated. A neutron source and detector are manufactured together, and the interaction between the source and the borehole environment is measured. The source material is Americium-241/Beryllium. This device detects the neutrons emitted by its own source that are scattered back to the detector by collisions primarily from hydrogen atoms surrounding the borehole. The measurements indicate relative moisture content.

When this detector is employed with either Gamma 2 or Gamma 4, it is referred to as the Neutron Moisture Logging System (NMLS). NMLS logging procedures are presented as Chapter 7.0.

5.4 Passive Neutron Detector

Stoller uses a Helium-3 detector to measure neutrons emitted by primarily transuranic radioactive isotopes in the subsurface. This detector is not calibrated and is used only to collect qualitative measurements. These measurements are used to indicate the presence of transuranic radioactive isotopes.

When this detector is employed with either Gamma 2 or Gamma 4, it is referred to as the Passive Neutron Logging System (PNLS). PNLS logging procedures are presented as Chapter 8.0.

5.5 Neutron Capture Detector

Stoller uses an HPGe detector combined with a Californium-252 neutron source as a neutron capture tool. The data acquired with this tool are used to delineate radioactive and non-radioactive components of waste sites during site characterization and other environmental investigations.

When this detector is employed with Gamma 4, it is referred to as the Neutron Capture Logging System (NCLS). NCLS logging procedures are presented as Chapter 9.0.

5.6 Directional Gamma –Ray Detector

Stoller uses an HPGe detector combined with windowed-tungsten shield. Tubing is attached to the top of the tool allowing the window to be aligned to specific azimuthal directions. The data collected with this tool are used to identify the radial position of point source gamma-ray-emitting radionuclides. The depth locations of interest are first determined by passive gamma-ray logging.

When this detector is employed with Gamma 4, it is referred to as the Azimuthal Logging System (AZLS). AZLS logging procedures are presented as Chapter 10.0.

6.0 Portable Calibration and Field Verification Check Sources

Each SGLS currently has the capability to acquire data using the different sondes. Before and after logging, a system check is performed to judge the quality of the system's efficiency and energy resolution. These system checks are called verification or calibration spectra and data collected from verifications are compared to published acceptance criteria. The vehicles employ different field verifiers depending upon the type of sonde being utilized and are as follows:

- Portable KUTh Field Verifier
- HRLS ^{137}Cs Calibration Check-Source
- Neutron Calibration Standard

6.1 Portable KUTh Field Verifier

A low-intensity (exempt quantity) gamma-ray source, called a KUTh Field Verifier (Figure 1-18), is used to check system performance when acquiring data.

Amersham certifies that the verifiers contain potassium-40 (^{40}K), uranium-238 (^{238}U), and thorium-232 (^{232}Th) in such minute quantities that the U.S. Nuclear Regulatory Commission and the radiation control agencies of the various states do not impose licensing requirements. The quantity of radioisotopes and the dose rate at the surface of the verifier are below limits for limited quantity radioactive material established by the DOT.

The verifiers are approximately 11 in. in diameter by 13.5 in. in length. The KUTh mixture is encapsulated in a standard aluminum clam-shell configuration with a 4-in.-diameter access hole in the center; the verifiers weigh approximately 64 lbs. The following table is a summary of the source test report received from Amersham Corp. with the verifiers. Activities for all KUTh verifiers are approximately the same.

Isotope	Activity	Concentration
^{40}K	1.68 µCi	11.7%
^{238}U	0.23 µCi	40 ppm
^{232}Th	0.17 µCi	90.5 ppm

The KUTh Field Verifier is a portable device that is carried in a compartment and secured behind a locking door. An Onsite Routine Radioactive Shipment Record (ORRSR), issued by site transportation, safety and radiological control will accompany the KUTh verifier at all times.

Figure 18. Portable KUTh Field Verifier

Figure 19. Verifier Compartment

6.2 High Rate Logging System ^{137}Cs Calibration Check-Source

A planar HPGe detector is used for acquiring spectral data from boreholes with very high gamma flux that saturates a SGLS sonde, making that data unusable for analysis. To measure radiation intensity in this environment, a planar detector was manufactured utilizing a very small HPGe crystal (6 mm x 8 mm). Testing determined the gamma-ray intensity from the portable KUTh field verifiers described above was of insufficient strength to employ them as a verification source for calibrating the HRLS sonde.

A 200-µCi ^{137}Cs source, identified as 1013, was procured and a steel and tungsten container was built to provide shielding and accommodate sonde calibration (Figure 1-19). The HRLS check-source is affixed to a pair of sliding rails on Gamma 1 in a locking compartment and weighs approximately 80 lb. A steel lid shields and secures the top.

The ^{137}Cs source is encapsulated in a 2-in.-long by 0.25-in.-diameter aluminum tube sealed in the side of the container 3 in. off the bottom. This configuration makes the gamma radiation a point source where detector/container alignment is important for acquiring consistent calibration spectra. Two reference marks, one each on the sonde and container, are aligned when the sonde is placed inside the container from the top.

An Onsite Routine Radioactive Shipment Record (ORRSR), issued by site transportation, safety and radiological control will accompany the 200-µCi ^{137}Cs verifier at all times.

6.3 Neutron Calibration Standard

The neutron moisture gauge employs a 50-mCi Americium-241/Beryllium source that is a part of the 503-model detector manufactured by CPN International, Inc. As an active component of the 503-detector, the source is used for both calibrating the sonde and measuring formation moisture (Figure 1-20). A specially designed container filled with paraffin is the source shield and calibration standard and fits on the end of the detector where the source is located. When performing verification, a spectrum is collected with the source in the calibration standard/shield and a count rate check is performed. When logging, the calibration standard/shield is removed so the neutron source can actively interact with the borehole environment.

Both the detector and calibration standard/shield are carried in a Type A instrument container. An Onsite Routine Radioactive Shipment Record (ORRSR), issued by site transportation, safety and radiological control will accompany the 50-mCi Americium-241/Beryllium neutron moisture gauge at all times.

Figure 20. Moisture Gauge in Calibration Standard/Shield

7.0 Logging

7.1 Computer Automated Spectral Acquisition System II LOG Program

CASASII LOG is a comprehensive logging program that integrates both equipment and software. This program is based on the EG&G Ortec Advanced Data Collection and Management System (Greenspan).

The CASASII LOG program has the ability to monitor the vehicle's action while acquiring data, receiving and storing acquired data, and controlling sonde depth via automatic hoist control in a borehole over a depth interval specified by the user. To accomplish this work, the CASASII LOG program is interfaced to the logging system. If equipment breakdown occurs or is missing, the CASASII LOG program alerts the user and/or suspends further work progression until the equipment is repaired or sensed to be present, thus completing a set of checks and balances within the CASASII LOG program.

Detailed operating procedures are included in the *CASASII LOG User's Manual* (Greenspan) on file at the field office.

Every new log run has a separate Log Data Sheet entry. Original Log Data Sheets are kept with the borehole file at the Stoller office as a permanent record.

Spectrum analysis is performed in accordance to the *Hanford Tank Farms Vadose Zone Data Analysis Manual* (DOE 2003).

7.2 Field Logbooks

Each logging vehicle carries a field logbook where the user can record the day's activities and observations. Entries include date, times, and names as well as vehicle operation and performance. The logging engineers also note whether or not a tool has passed its acceptance criteria. Start and stop time, file names, and depth intervals are also recorded. Field logbooks are kept on the vehicles to track and record pertinent information that is unique to a specific day.

7.3 SGLS Reference Notebooks

A notebook will be kept in each logging truck to store pertinent and required information for use by the logging engineer. The items required to be containing in these notebooks are listed below. The Project Coordinator is responsible for keep all items up to date. Other items may be added to these notebooks as needed.

7.3.1 Calibration Certificates

A Calibration Certificate is a referenceable document issued after a system has been calibrated. This document provides the dead time correction function, the calibration function and the acceptance criteria for a particular logging system. The *Gamma 4A Calibration Certificate* (Koizumi 2005) is an example of one such certificate. The most current certificate for each logging system will be kept in the SGLS reference notebooks. This document will provide the logging engineer with the current acceptance criteria for that particular logging system.

7.3.2 Logging System Status Sheet

The Logging System Status Sheet (Figure 1-21) is a table that lists all the borehole geophysical logging tool and trucks. A logging tool when combined with a truck comprises a logging system. Each tool is assigned a letter (e.g. The 70% HPGe tool is E). Each truck is also assigned a letter (e.g. Gamma 4 is the D truck); therefore, logging system DE consists of Gamma 4 with the 70% HPGe tool. This table notes the status of each tool and truck. It also provides the current calibration status (effective date and calibration reference) of each logging system. This sheet is updated weekly. The logging engineer will use this sheet to verify a logging system is currently calibrated and as a reference to determine the effective calibration date and calibration document number.

7.3.3 Logging Truck Configuration Record

The Logging Truck Configuration Record (Figure 1-22) lists the cable length, available sondes, termination resistor settings, amplifiers, MCAs, and field verifiers used on each truck. This record will be updated during each calibration and when equipment is replaced or repaired. This record along with the calibration data will be supplied to the Project Geophysicist each time a system is calibrated.

7.3.4 Radiological Work Permits

Radiological Work Permits (RWPs), (Figure 1-23) are use to establish administrative control limits for dose rates and contamination limits for work control by these procedures. The RWP also lists the types of radiation emitted, the primary isotopes, dosimetry, radiological control technician (RCT) coverage and PPE requirements. The RWPs are issued by the site radiological control organization. Current copies of all relevant RWPs will be maintained in the SGLS reference notebook. The Project Coordinator will be responsible for ensuring that a copy of all current RWPs are included in the notebook.

Logging System Status   Week Ending 05/13/2005

Sonde	Current Status ↓Sonde / Truck →	Gamma 1 (A) HO 68B-3574	Gamma 2 (B) HO 68B-3572	Gamma 4 (D) HO 68B-3573
			Cable problem[1]	
A (35% HPGe) 34TP20893A				**DA** (05/11/05) DOE-EM/GJ891-2005
B (35% HPGe) 36TP21095A	detector failure 4/15/05			
C (HRLS) 39A314		**AC** (04/06/05) DOE-EM-GJ865-2005		
D (35% HPGe) 34TP11019B	Detector suspect: out of service			
E (70% HPGe) 34TP40587A		**AE** (03/04/05) DOE-EM/GJ864-2005		**DE** (12/21/04) DOE-EM/GJ854-2005
F (NMLS) H380932510	Tank farms retrieval support		**BF**[2] (10/07/04) DOE-EM/GJ754-2004	
G (35% HPGe) 34 TP10951A	Dewar to be replaced			
H (NMLS) H310700352				**DH** (3/24/05) DOE-EM/GJ855-2005
I (PNLS)[3] U1754			**BI** Calibration not required	**DI** Calibration not required
J (NCLS) 34 TN1104A	^{252}Cf source due in June			**DJ** (calibration planned)
K (AZLS)	Not currently deployed			
L				
M (NMLS) H340207279				**DM** (3/24/05) DOE-EM/GJ856-2005
N 60% HPGe 45-TP22010A		**AN** (calibration planned)		**DN** (calibration planned)

[1] Loss of counts at higher energy and peak distortion suggest impedance mismatch most likely associated with cable damage.
[2] Total counts do not appear to be affected by cable problem.
[3] PNLS data may have been collected under "L" sonde designation prior to 03/01/05.

Figure 21. Logging System Status Sheet

Stoller		Logging Truck Configuration Record	
		Truck ID	
		Vehicle No	
		Date	
Cable Length (approx), ft:			
		Channel 1	Channel 2
Available Sondes			
Termination Resistor, ohms			
Amplifier	Model		
	Serial Number		
MCA	Model		
	Serial Number		
Verifier(s)			
Notes			
Verified By:			

Figure 22. Logging Truck Configuration Record

HANFORD RADIOLOGICAL WORK PERMIT

Contractor: **Fluor Hanford**

General [X] Job Specific [ ]	Tech. Document No. FH/Stoller MOU, GRP-TA-005-T	Location Code GW	RWP Number **GW-05-006**
Start Date 2/3/2005	End Date 12/31/2005	Responsible Organization Stoller	

Job Location
Boreholes on the Hanford Site

Job Description and Type of Area: This RWP provides administrative control of borehole logging activities conducted for FH by Stoller throughout the Hanford site. Boreholes to be logged may be located in posted URMAs, SCAs, or Radiological Controlled areas.

Primary Isotope(s): [X] MFP [ ] MAP [ ] Cs [] Sr [ ] H-3 [ ] U [ ] Pu [ ] Th, Am

Radiation Emitted	Estimated Dose Rates	Contamination Levels	Radiological Worker Training Req.
[] Alpha [x] Beta [x] Photons [ ] Neutrons	General Area: <0.5 mrem/h Maximum Contact: <0.5mrem/h	Beta-gamma: <1,000 dpm/100cm^2 Alpha: <20 dpm/100cm^2	I [ ] II [X]

Internal Dosimetry Requirements (for routine work under this RWP, except those entering for observation only)
[X] Annual Whole Body Count (**WC**) [ ] Lung Count [ ] Urinalysis Isotopes to Test for (if any):

MINIMUM RADIOLOGICAL PROTECTION REQUIREMENTS

	HPT Coverage		Dosimetry
	Continuous	X	HSD - TLD
SI2	Intermittent		HCND - TLD
	Start of Job		Pocket Dosimeter
	End of Job		Electronic Dosimeter
	Self Survey (if qualified)		Finger Rings
SI2	HPT Survey Required		Time Keeping
	Auto. Survey Device	X	Entry Control System
			PNAD

MINIMUM PROTECTIVE EQUIPMENT

	Coveralls		Shoe Covers
	Lab Coat		Canvas Boots
	Waterproof Suit		Rubber Overshoes
	Gortex Suit		Rubber Boots
	Cap		Full Face Respirator
	Hood		PAPR
	Surgeon's Gloves		Supplied Air Respirator
SI3	Leather Gloves		SCBA
SI3	Canvas & Surgeon's Gloves		Undressing Assistance
SI3	Waterproof Gloves		Air Sampling Required
	No Personal Outer		ARM Required
	Modesty Clothing		
	Raincoat/ face shield		

SPECIAL INSTRUCTIONS (SI)

1. **WORK AREA VOID LIMITS:**
   General Area Dose rates: ≥5 mrem/hr
   General Area Contamination: ≥1,000 dpm/100 cm^2 βγ

   IF VOID LIMITS ARE EXCEEDED:
   a. Stop work and place work area into a safe condition.
   b. Notify RadCon Supervisor
2. To determine contamination conditions, boreholes must be swabbed prior to gamma logging. Verification surveys of equipment and personnel are required at the end of the work day or upon completion of the borehole gamma logging activity, whichever comes first. Refer to GRP-TA-005-T for survey requirements. the
3. Wear gloves appropriate for the hazard when handling cables, material or equipment that has been down the borehole.
4. To ensure RCT availability, it is recommended that work be scheduled as far in advance as possible. Work may be scheduled through:

   Traci Rued 373-4049 or 430-5546
   Tom Bradfield 430-2939
   Steve Landsman 531-0612

COPY

ALARA Review: YES [ ] NO [X]	Pre-Job Briefing: YES [ ] NO [X]	Post-Job ALARA Review Required: YES [ ] NO [X]

RWP Prepared By: SD Landsman	Phone: 373-5525 or 531-0612	HPT Phone: 373-4049 / 430-5546
Line Mgt. Print: Steve Kos Sign:	Phone 376-6432 or 539-9497	Date 3/1/05
RC Mgt. Print: SD Landsman Sign:	Phone 373-5525 or 531-0612	Date 2/1/05
RWP Peer Reviewed:		Date 02-01-05

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Figure 23. Radiological Work Permit (RWP)

Stoller	Logging Request & Tracking Sheet	Tracking Number	
		Borehole Number	
		Borehole ID	

Location / Waste Site:	
Program:	OU:
Field POC:	Tech POC:

Charge Codes:	Logging:	Analysis:

Borehole Information

Drilling Method:	Depth:	D/W:	Casing:	Min ID:
Special Conditions:				

Logging Parameters

	Log	Depth Interval	Sample Inc	Count time	Notes
	SGLS (35%)		1 ft	200s RT	
	SGLS (70%)		1 ft	100s RT	
	HRLS		1 ft	300s RT	
	NMLS		0.25 ft	15s RT	
	PNLS		0.25	15s RT	
	NCLS		TBD	TBD	

RCT & IH History:

Waste Disposal Instructions:

Analysis Requirements (GJO-HGLP 1.6.3):

Date Required:	**Notes:**

Distribution

	Name	Phone	MSIN		Name	Phone	MSIN

Notes:

	Name	Date
Initiated By		
Logging Completed		
Analysis Completed		
Review Completed		
Log Issued		
Data Archived		
Data Archive Location		

Figure 24. Logging Request and Tracking Sheet

7.3.5 Memorandum of Understanding and/or Other Specific Project Plans

Various projects and site contractors may use a Memorandum of Understanding (MOU), Statement of Work (SOW), or other contracting mechanisms to specify logging, training, health and safety, and/or other project specific requirements. A copy of each relevant MOU or SOW will be included in the SGLS reference notebook.

7.3.6 Phone Lists (Stoller Personnel, Site Personnel, and Emergency)

Current phone lists will be included in each SGLS reference notebook. These phone lists will include but are not limited to Stoller personnel, site personnel, and emergency numbers.

7.3.7 Site Specific Alarm List w/Responses

Any site specific alarm lists with appropriate responses will be included in the SGLS Reference Notebook for quick reference.

7.4 Logging Request and Tracking Sheets

Logging Request and Tracking Sheets (Figure 1-24) will be used issued by the Project Coordinator to the Logging Engineer to communicate the following information required to perform logging: borehole number, location, program, points of contact, charge codes, borehole information, logging parameters, and waste disposal information. The Logging Engineer will use this form to record the history of RCT and industrial hygiene support. This form will follow the data through the analysis and reporting cycle providing analysis requirements and a distribution list for the Log Data Report. A sign off list is provided at the bottom of the form to track a logging request from the time it was initiated to the time the log was issued and archived.

7.5 Log Data Sheets

Log Data Sheets (Figure 1-25) are a record of the logging engineer's actions, set up, and assumptions when a borehole is logged. Log Data Sheets are kept to track and record pertinent information that is unique to a specific borehole-logging event. The logging engineer is responsible for filling out the record with filenames, depth, actions, and observations that would affect the analysis and interpretation of the acquired data. The logging engineer also records the "Effective Calibration Date" and "Calibration Reference" on the Log Data Sheets. This ensures the tool being used has a current valid calibration. The "Effective Calibration Date" and "Calibration Reference" are located on the Logging System Status Sheets, which are kept in the SGLS Reference Notebooks.

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S.M. Stoller Corp.	**Borehole**	
BOREHOLE DATA SHEET	**Date**	

Borehole Information:

Site:			
Coordinates	North:	West:	Elevation:
Drill Date:	Type:	Depth:	Depth Datum:
Groundwater Level:	GWL Date:	GWL Reference:	
Comments:			

Casing Information:

Type	Stickup (ft)	Outer Diameter (OD) (in.)	Inside Diameter (ID) (in.)	Thickness (in.)	Top (ft)	Bottom (ft)

Borehole Notes:

Signature:	**Date:**

Figure 25. Log Data Sheet

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S.M. Stoller Corp. **BOREHOLE DATA SHEET**	**Borehole**	
	Date	

Logging Equipment Information:

Log System:	Type:	Serial No.:
Logging Procedure:		
Effective Calibration Date:	Calibration Reference:	

Log Run Information:

Date				
Start Depth (ft)				
Finish Depth (ft)				
Count Time (sec)				
Live/Real				
Shield				
MSA Interval				
Log Speed				
Pre-Run Verification				
Start File				
Finish File				
Post-Run Verification				
Depth Return Error (in.)				
Comments:				

Logging Operation Notes:

Data File Location:	
Signature:	**Date:**

Figure 25 (con't). Log Data Sheet

7.6 Data Tracking Record

The Data Tracking Record (Figure 1-26) will be used by the Logging Engineer to record the data files and Log Data Sheets that are copied to the Zip disks or other mass storage device for transfer to the office. The Logging Engineer will record the borehole number, Zip disk number, the start file number, the end file number, and initial the record. These records will be delivered to the Project Coordinator who will be responsible for transferring these data to the office server and noting the data location and date transferred on the record.

7.7 Field Verification Spectra and Acceptance Criteria

Field verification spectra are collected during normal logging operations before and after acquiring borehole data as a component of the logging system's quality control. These spectra are collected and analyzed to establish an energy calibration and verify the following:

- Full spectrums were collected.
- Gaussian shaped peaks.
- Energy resolution.

The results of pre-verification spectra are compared to acceptance criteria. Acceptance criteria are ranges of acceptable values for intensities and full width at half maximum (FWHM) of selected spectral peaks in the field verification spectra (DOE 1999a). For logging using HPGe detectors and KUTh Field Verifiers, the system passes or fails an acceptance test depending on how the intensity and FWHM of the 609.3-, 1460.8-, and 2614.5-keV spectral peaks compare to established acceptance criteria. Similar tests are applied to HRLS verification spectra using the 661.6-keV spectral peak when collected from the ^{137}Cs Calibration Check-Source. For logging using the NMLS, the system passes or fails an acceptance test depending on how the neutron count rate compares to the established acceptance criteria. The logging engineer will determine whether or not a tool passes the acceptance criteria and note this in the logbook.

New acceptance criteria are established annually or during each new calibration from data collected in the various check-sources at the Hanford borehole calibration standards during calibration. Acceptance criteria are published in the calibration certificates.

7.8 Repeat Log Runs

A repeat log run is a method of checking the data acquisition system by verifying depth control and data quality between one log run and another. Repeat log run data are collected regularly and usually cover 10 percent of a logged interval.

Stoller

Data Tracking Record

Borehole Number	Zip Disk#	Data Transfer Date/Location/Initials	Start File Number	End File Number	Initials

Figure 26. Data Tracking Record

7.9 Depth Return Error

At the completion of logging, the accuracy of the zero-depth reference is checked. The sonde is returned to the sonde/borehole zero-depth reference. Once the reference is aligned, depth readouts on the Acquire Screen and OC should both display 0.00 ft. If the sonde/borehole reference is not at 0.00 ft, the sonde is moved until 0.00 ft is displayed on the acquire screen. The distance between the sonde/borehole is measured and the value is recorded on the Log Data Sheet. This information will be utilized during analysis and comparison of log data acquired from different surveys.

If the sonde mark is above the zero-depth reference, the error is recorded as +X.XX ft; if the mark is below the zero-depth reference, the error is recorded as –X.XX ft.

7.10 HPGe Detectors and High Activity Zones

During logging, the detectors can become saturated in zones of high gamma-ray flux. Detector saturation occurs when the logging system is unable to record spectra with distinct full energy peaks (DOE 1999b). The records of these zones indicate extremely high-count rates, but no analyzable or blank spectra are collected. In these cases, the dead time is tracked during logging and the log run is terminated when the high activity causes the dead time to exceed 40 percent or saturate the detector.

The depth, file number, count rate, and percent dead time are noted on the Log Data Sheet. A new log run is initiated by changing the collecting time parameter to 20seconds *Real Time* using the CASASII LOG program Acquire Spectra window. Overlap 1 ft and continue with a new log run.

Continue logging through the high activity zone even though no usable data are acquired so a record is made. Terminate the log run when a low activity boundary is reached and the dead time falls to less than 40 percent. In the low activity zone, initiate a new log run by changing back the collecting time parameter to match the Logging Request and Tracking Sheet. The depth, file number, count rate, and percent dead time are noted on the Log Data Sheet so the interval can be relogged with the HRLS. Overlap 1 ft and continue with a new log run.

At the logging engineer's discretion, high activity zones can be logged using the tungsten shield if the dead time is not excessive or if the zone is not extremely thick. This involves moving the sonde to the surface, making a depth return check, placing the tungsten shield on the sonde, and starting a new log run. The depth, file number, count rate, and percent dead time are noted on the Log Data Sheet.

8.0 References

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9.0 Glossary

The terms in this glossary are defined as they relate to the logging system and logging operations conducted on the Hanford Site.

Acceptance Criteria: Ranges of acceptable values of selected spectral peaks in field verification spectra against which measurements collected by the logging system are compared for accuracy and repeatability.

Borehole: A small diameter hole dug in the ground by a drilling rig and completed using steel casing of various size for monitoring a portion of the vadose zone.

Cable Wrap: A condition where the logging cable fails to be tightly spooled onto the hoist drum. This condition could cause the logging cable to snag or unreel if the hoist continued to move. An electronic sensor located on the hoist automatically applies the hoist brake if an overwrap condition occurs.

Calibration: A process where a series of measurements are recorded by the logging system from a model of known strength and composition from which concentrations and error measurements can be determined.

CASASII: Acronym for *Computer Automated Spectral Acquisition System II,* which is the main logging program (LOG) that controls and monitors the data acquisition process.

Clock Time: Real time.

Count: A measured pulse of radiation.

Crossover Sub: A housing configured to fit, adapt, or attach to different connections, making a complete sonde.

Data Acquisition: A process where signals from a detector are collected then sent to an amplifier/analyzer and stored on a computer for analysis and interpretation. A.K.A. logging.

Data Directory: Where all files, which contain spectral and verification data, are stored. A directory is entered on the File/Directory command screen from the CASASII Main Menu.

Dead Time: The time that an electrical device spends processing electrical signals and is automatically written on spectrum files by the CASASII LOG program. Dead time is calculated by subtracting live time from clock time and dividing the result by clock time.

Detector: A device that senses the interactions from radiation and converts the interaction to a measurable signal.

File Header: The first through fifth characters of all data filenames and is entered by the user on the LOG Initialization screen from the CASASII Main Menu. The CASASII LOG program will determine the sixth through eight characters and attach the <*.CHN> suffix extension to the data file.

Gain: A factor by which a pulse is amplified.

Live Time: The elapsed time a system requires to process detector pulses. The CASASII LOG program displays live time on the Acquire Screen during logging.

Log Event: A term used to describe all log run data acquired from a specific borehole, sonde, and calendar date. Log events are recorded alphabetically starting with "A" and progress forward if multiple log events are conducted.

Log Run: A term used to describe a single set of data that were acquired from a borehole in consecutive order, without interruptions or breaks, and inclusive to a specific depth interval. Log runs are numbered numerically starting with number "1" and progress forward if multiple log run data are acquired.

Logging: The process of acquiring geophysical data from a borehole.

Multi Channel Buffer (MCB): An instrument that collects output signals from a spectroscopy amplifier, performs pulse-height-analysis (PHA) on those signals and displays the results in real time as spectra.

Operating RPM: Represents the optimal engine speed between 1,100 and 1,400 RPM so the hydraulic pumps can adequately supply the fluid force to power the Hydra-Gen®, crane and hoist.

Post Verification: The process of collecting a spectrum at the end of a log run or end of the day in a calibration or field verification check-source to record and check the performance of the logging system.

Pre Verification: The process of collecting a spectrum at the beginning of a log run or beginning of the day in a calibration or field verification check-source to record and check the performance of the logging system. Verification spectra are compared to acceptance criteria.

Pulse: Emitted energy that a detector can count given enough time.

Pulse Height Analyzer (PHA): An electrical device that collects counts from a detector and converts them into a record as a function of energy.

Real Time: Clock time. The CASASII LOG program displays real time on the Acquire Screen during logging.

Repeat Log Run: A method of observing the performance of the logging system by comparing data and depth control measurements between one log run and another.

Sheave Wheel: A mechanical device used for hoisting, guiding, or routing a cable.

Sonde: Electronic or mechanical device(s) inside a cylindrical housing that are conveyed within a borehole used for collecting geophysical data.

Spectra: Recordings of physical measurements collected with a sonde. Spectra are graphically displayed and saved as files on the logging computer by the CASASII LOG program.

Total Count Rate: The sum of radiation pulses collected by a single spectrum, divided by its collection time, and expressed in units of counts per second. The CASASII LOG program displays total counts on the Acquire Screen during logging.

Trained Personnel: A person trained by Stoller to log and collect geophysical data while operating an SGLS.

Vadose Zone: A geologic term used to describe the interval that exists above the water table and below the ground surface.

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Alan W. Pearson — Date
S. M. Stoller Corp., Hanford Office

Approved By:

Brian W. Mathis, Manager — Date
S. M. Stoller Corp., Hanford Office

1.0 Purpose and Scope

This procedure provides instructions for safely moving the geophysical logging trucks.

2.0 Responsibilities

2.1 Stoller Geophysical Logging Project Manager

2.1.1 The Project Manager is responsible for ensuring all personnel using this procedure have been provided the appropriate training required to perform this procedure.

2.1.2 The Project Manager is responsible for approving this procedure.

2.2 Project Coordinator

2.2.1 The Project Coordinator is responsible for providing updates to this procedure and ensuring copies of this procedure are maintained on each logging vehicle.

2.2.2 The Project Coordinator is responsible for providing the Logging Engineer all applicable information required to perform this procedure including but not limited to, site maps, shipping papers, and vehicle inspection forms.

2.3 Geophysical Logging Engineer

2.3.1 The Geophysical Logging Engineer is responsible for performing this procedure and providing the Project Coordinator with feedback to update the procedure when necessary.

2.3.2 The Geophysical Logging Engineer is responsible for obtaining and maintaining a Class B Commercial Driver's License with an air brake endorsement.

3.0 Procedure

3.1 Inspection

3.1.1 Geophysical Logging Engineer will perform the following inspection: a pre-trip vehicle safety inspection following the D.O.T. *Federal Motor Carrier Safety Regulations* and Washington State's *Commercial Driver's Guide* to be satisfied that the motor vehicle is in safe operating condition.

3.2 Sign and Verify Shipping Papers

3.2.1 The Geophysical Logging Engineer will verify all required shipping papers are complete. This may require a survey by site radiological control personnel.

3.3 Vehicle Start Up

3.3.1 Go to the driver's cab and prepare to start the vehicle.

3.3.2 Place the vehicle's 6-speed transmission in NEUTRAL.

3.3.3 Switch OFF the PTO (right hand position, red LED OFF).

3.3.4 Switch the Front Axle to Disengage (right hand position, red LED OFF).

3.3.5 Switch the Transfer Case to HIGH (left hand position).

3.3.6 Push in the clutch.

3.3.7 Start the engine and monitor the gauges.

3.4 Air Brakes

3.4.1 Observe the following, with the engine running:

a. Ensure the air-pressure warning buzzer is operating and air pressure is increasing.

b. Wait for the air tank pressure to reach the "cut-out" level around 70 PSI.

3.5 Parking Brake Control

3.5.1 Release the parking brakes by pushing IN the diamond shaped, yellow, push-pull control knob located on the right side of the dash.

3.6 Driving

3.6.1 Licensed drivers will drive the vehicle according to normal and standard operating rules of the road obeying traffic laws at all times.

3.6.2 Drive to the borehole location.

3.6.3 Stop the vehicle and engage the parking brake.

3.6.4 Place the vehicle's transmission in NEUTRAL.

3.7 Final Actions

3.7.1 Proceed with the *Borehole Set Up Procedure* (Chapter 3.0).

Prepared By:

______________________________ ______________________

Robert R. Spatz Date
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______________________________ ______________________

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Approved By:

______________________________ ______________________

Brian W. Mathis, Manager Date
S. M. Stoller Corp., Hanford Office

1.0 Purpose and Scope

This procedure provides instructions for safely positioning and setting up a geophysical logging truck at a borehole location.

2.0 Responsibilities

2.1 Stoller Geophysical Logging Project Manager

2.1.1 The Project Manager is responsible for insuring all personnel using this procedure have been provided the appropriate training required to perform this procedure.

2.1.2 The Project Manager is responsible for approving this procedure.

2.2 Project Coordinator

2.2.1 The Project Coordinator is responsible for providing updates to this procedure and insuring copies of this procedure are maintained on each logging vehicle.

2.2.2 The Project Coordinator is responsible for providing the Logging Engineer all applicable information required to perform this procedure including but not limited to, site maps, shipping papers, and vehicle inspection forms.

2.3 Geophysical Logging Engineer

2.3.1 The Geophysical Logging Engineer is responsible for performing this procedure and providing the Project Coordinator with feedback to update the procedure when necessary.

2.3.2 The Geophysical Logging Engineer is responsible for obtaining and maintaining a Class B Commercial Driver's License with an air brake endorsement.

3.0 Procedure

3.1 Position the Vehicle Over a Borehole

3.1.1 Walk around the borehole, look for ground and overhead hazards.

3.1.2 Select a level location between 11 and 16 ft away from the borehole.

3.1.3 Carefully back up the vehicle to that area - use a spotter if possible. When backing, align the borehole and centerline of the vehicle.

3.1.4 Stop when the rear bumper reaches the 11- to 16-ft range. Check the alignment of the centerline again and adjust as necessary.

3.1.5 Engage the parking air brake; pull the yellow diamond OUT.

3.1.6 Leave motor ON and idling.

3.1.7 Place the vehicle's transmission in NEUTRAL.

3.1.8 Set out wheel chocks.

3.1.9 Set up instrument cabin ladder, hoist equipment ladder, and open canvas drape.

3.1.10 Top-off the liquid nitrogen dewar if necessary by turning ON the auto-fill system.

3.2 Go to the Hydra-Gen® Compartment

3.2.1 Open and latch the generator's compartment door against the vehicle.

3.2.2 Check that main power cable coming from the Hydra-Gen® is connected to the main power receptacle.

3.2.3 Main circuit breaker switch is ON.

3.3 Go to Driver's Cabin and Set Up Power Train and Air Switch

3.3.1 Depress vehicle clutch.

3.3.2 Switch transfer case air switch to NEUTRAL (middle position).

3.3.3 Switch front axle to disengaged (right hand position).

3.3.4 Switch PTO air switch ON (left hand position, red LED illuminates).

3.3.5 Shift the vehicle's transmission into 6th gear.

3.3.6 Slowly engage vehicle clutch.

3.4 Attach Sheave Wheel Assembly to Crane

- Prior to operating the crane the safety conditions listed in Attachment 1 must be understood and followed.

- Only Stoller personnel trained to this procedure are authorized to operate the crane.

3.4.1 Go to the Power Distribution Panel and turn ON the circuit breaker labeled *Console*.

3.4.2 Increase the engine speed to operating rpm (approximately 1200 rpm).

3.4.3 Turn OFF the circuit breaker labeled *Console*.

3.4.4 Go to the crane, extend and deploy the outriggers.

3.4.5 Level the crane using the leveling sight gauge on the back bumper.

3.4.6 Move the crane from its folded position.

3.4.7 Place the sheave wheel jig in the holder on the bumper and place the sheave wheel assembly in the jig. Note: the encoder box faces toward the driver's side of the vehicle.

3.4.8 Manipulate the crane over the jig and attach the sheave wheel's shackle securely to the end of the crane.

3.4.9 Connect the retractile cord to the encoder receptacle found on the side of the encoder box.

3.5 Extend Crane Over Borehole

3.5.1 Use the levers on the Distributor Panel to position the sheave wheel/crane over the borehole.

3.5.2 Loop the logging cable through the sheave wheel.

3.5.3 Lift the crane boom to the horizontal position and hook the vertical support poles to the end of the crane.

3.5.4 Apply a light down force on the vertical poles with the boom to set the poles firmly in place.

3.6 Attach SGLS, HRLS, NCLS, AZLS or PNLS Sonde to Cable Head and Position in Verifier (Option 1)

3.6.1 Check that the NIM Bin power switch is OFF before connecting the sonde to the cable head.

3.6.2 Disconnect and remove the sonde from the auto-fill system (not required for PNLS sonde).

3.6.3 Align the 22-pin and step-up connector on the sonde to the notch and step-down connector on the cable head.

3.6.4 Attach the two pieces together being careful not to break or damage the pin connectors and O-ring seal.

3.6.5 Hand-tighten the cable head nut to the sonde.

3.6.6 Use a spanner wrench to securely tighten the sonde and cable head.

3.6.7 Position the centralizer on the sonde when logging boreholes with an inside diameter greater than 6 inches.

3.6.8 Remove the KUT verifier, or moisture gauge for the PNLS sonde, from the locked compartment and position it over or near the borehole. Place the sonde in the verifier, or next to the moisture gauge for the PNLS sonde.

3.7 Attach NMLS Sonde to Cable Head (Option 2)

3.7.1 Check that the NIM Bin power switch is OFF before connecting the crossover sub to the cable head.

3.7.2 Attach the crossover sub to the cable head.

3.7.3 Align the 22-pin and step-up connector on the crossover sub to the notch and step-down connector on the cable head.

3.7.4 Attach the two pieces together, being careful not to break or damage the pin connectors and O-ring seal.

3.7.5 Hand-tighten the cable head nut to the crossover sub.

3.7.6 Use a spanner wrench to securely tighten the crossover sub and cable head.

3.7.7 Position the centralizer on the crossover sub when logging boreholes with an inside diameter greater than 6 inches.

3.7.8 Remove the detector/source/shield assembly from the instrument/storage case keeping the shield/calibration standard ON.

3.7.9 Attach the detector/source/shield assembly to the crossover sub and secure.

3.8 Perform Power Up, Power Down Sequence

3.8.1 Enter the Instrument Cabin.

3.8.2 Check that all switches and circuit breakers are in the OFF position.

3.8.3 Perform the Power Up, Power Down Sequence included in Chapter 4.0.

Attachment 1. Safety Conditions for Ferrari Crane Operation

1. Maneuvering and use of the crane must be carried out by authorized personnel only.

2. Crane must be operated on firm level ground.

3. Before operating the crane, make sure the vehicle brake is on and that the vehicle is stabilized.

4. Pull out completely and secure the stabilizer cross-beams. Operate the stabilizer jacking legs without unloading the vehicle suspension and close the valves on the legs.

5. Before starting any operation make sure that no one is working within the working area of the crane.

6. Before starting any job, check all safety devices. If anything is not functioning properly, stop work and have device repaired or replaced.

7. Check that the load to be lifted does not exceed the values given on the capacity plate and that the sheave wheel, cable head and logging cable are undamaged.

8. Do not begin maneuvering the crane without have first received prescribed signal.

9. Do not begin to maneuver the crane until all personnel have been signaled.

10. Do not start or stop crane abruptly. Maneuvering should be gradual and smooth.

11. Avoid making load swing, especially in order to bring it down outside the normal operation area of the crane; avoid dropping at an angle.

12. Avoid carrying out load lifting and transporting maneuvers over working and transit areas. Whenever this is inevitable warn with appropriate signal of both start of maneuver and movement of load.

13. Before leaving operating position, return all controls to zero, do not leave load suspended and disconnect power take-off or isolation switch.

14. Keep at a distance of over 5 meters from live wires.

15. Mechanical extensions that are not used must be dismantled.

16. Make periodical checks on the crane brackets, condition of steel framework, hoses, clevis, sheave wheel, cable head and logging cable.

17. During transport the crane is to be placed in a rest position on the back bumper or in such a way as to prevent accidental or uncontrolled movements.

Note: This list of Safety Conditions was modified from the *Ferrari Series 535-545 Operator's Manual*, First Edition, October 1992.

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Alan W. Pearson S. M. Stoller Corp., Hanford Office	Date

Approved By:

Brian W. Mathis, Manager S. M. Stoller Corp., Hanford Office	Date

1.0 Purpose And Scope

The logging system has a specific "Power Up, Power Down Sequence" that is followed when applying electrical power to the system. The order in which the circuit breakers and equipment switches are turned ON and OFF can affect supporting systems and possibly damage electrical circuitry if performed out of sequence.

2.0 Responsibilities

2.1 Stoller Geophysical Logging Project Manager

2.1.1 The Project Manager is responsible for insuring all personnel using this procedure have been provided the appropriate training required to perform this procedure.

2.1.2 The Project Manager is responsible for approving this procedure.

2.2 Project Coordinator

2.2.1 The Project Coordinator is responsible for providing updates to this procedure and insuring copies of this procedure are maintained on each logging vehicle.

2.2.2 The Project Coordinator is responsible for providing the Logging Engineer all applicable information required to perform this procedure including but not limited to, site maps, shipping papers, and vehicle inspection forms.

2.3 Geophysical Logging Engineer

2.3.1 The Geophysical Logging Engineer is responsible for performing this procedure and providing the Project Coordinator with feedback to update the procedure when necessary.

2.3.2 The Geophysical Logging Engineer is responsible for obtaining and maintaining a Class B Commercial Driver's License with an air brake endorsement.

3.0 Procedure

The following Power Up, Power Down Sequence assumes that both the *Vehicle Preparation Procedure* (Chapter 2.0) and the *Borehole Set Up Procedure* (Chapter 3.0) are completed.

3.1 Power Up, Power Down Sequence

3.1.1 Go to the Instrument Cabin and perform the following steps:

a. All circuit breakers and individual power switches should be in the OFF position at the beginning of this sequence.

b. Turn ON circuit breakers labeled Sensor and Console located on the DC side - red LED labeled “Console” on the OC illuminates and a red LED labeled “DC Power” on the Sensor Panel illuminates.

c. Apply the Hoist Brake on the Operations Console - red LED labeled “Brake” illuminates.

d. Increase engine speed to Operating RPM between 1,100 and 1,400 RPM. Check the Hydra-Gen® frequency meter to ensure nominal 60 Hz.

e. Turn ON the Computer, Wall-1, Air Conditioning, and Wall-2 circuit breakers on the AC side.

f. Energize the Uninterruptible Power Supply, (top button labeled “Test” for ON, bottom unlabeled button is OFF) hold for 1 second – two green-segmented LED graph displays illuminate on the UPS and a red LED labeled “AC Power” on the Sensor Panel illuminates.

g. Turn ON the Computer CPU – red LED illuminates and the operating system initiates. The computer monitor also turns ON with the CPU.

h. Turn ON the EG&G NIM Bin module in the equipment rack – an amber color pilot light illuminates. (Be sure a sonde is attached to the logging cable).

i. If SGLS, HRLS, NCLS, or AZLS logging, turn ON the toggle switch labeled “HV1” on the Signal Monitor Panel - a red LED illuminates. If NMLS or PNLS are employed, “HV1” is OFF.

j. When shutting the system down, the above sequence should be followed in reverse order.

Prepared By:

_______________________________ _______________________

Robert R. Spatz Date
S. M. Stoller Corp., Hanford Office

_______________________________ _______________________

Alan W. Pearson Date
S. M. Stoller Corp., Hanford Office

Approved By:

_______________________________ _______________________

Brian W. Mathis, Manager Date
S. M. Stoller Corp., Hanford Office

1.0 Purpose and Scope

This procedure provides the guidelines for conducting spectral gamma-ray logging using high-purity germanium (HPGe) detectors. Spectral gamma-ray logging is conducted to provide borehole profiles of both man-made and natural gamma-ray emitting radionuclides.

2.0 Responsibilities

2.1 Stoller Geophysical Logging Project Manager

2.1.1 The Project Manager is responsible for ensuring all personnel using this procedure have been provided the appropriate training required to perform this procedure.

2.1.2 The Project Manager is responsible for approving this procedure.

2.2 Project Coordinator

2.2.1 The Project Coordinator is responsible for providing updates to this procedure and ensuring copies of this procedure are maintained on each logging vehicle.

2.2.2 The Project Coordinator is responsible for communicating to the Logging Engineer all applicable information required to perform this procedure including, but not limited to the well construction information, logging parameters and waste disposal instructions. This information will be communicated through the use of Logging Request and Tracking Sheets.

2.3 Geophysical Logging Engineer

2.3.1 The Geophysical Logging Engineer is responsible for performing this procedure and providing the Project Coordinator with feedback to update the procedure when necessary.

3.0 Procedure

This procedure assumes that the following assumptions are met:

- The *Vehicle Preparation Procedure* (Chapter 2.0) is complete.
- The *Borehole Set Up Procedure* (Chapter 3.0) is complete.
- The *Power Up, Power Down Sequence* (Chapter 4.0) is complete.
- HV1 is ON and LN2 is flowing.
- The settings on the 973-amplifier match Figure 5-1.

The steps outlined below demonstrate just one method of setting up the CASASII LOG program for acquiring spectral gamma-ray data employing the SGLS. Use these steps as a guide to become familiar with the CASASII LOG program. For more detail, consult the *CASASII LOG User's Manual*, 1994 by Greenspan, Inc., Houston, Texas.

General keyboard strokes are listed below to maneuver through the CASASII LOG program.

- Pressing <ESC> returns the user to the CASASII Main Menu.
- Pressing <ALT+Arrow Key Right/Left> moves the cursors 20 channels.
- Pressing <CTRL+Arrow Key Right/Left> moves the cursors 200 channels.

3.1 Invoke the CASASII LOG Program

3.1.1 Start from the Windows 95 desktop screen and restart in MS-DOS mode by performing the following keyboard stokes:

a. Press <CTRL+ESC> to display the Windows Start Menu.

b. Point to "Shut Down . . ." using <Arrow Keys> and press <Return↵>.

c. Use the <Arrow Keys> and move to "Restart the computer in MS-DOS mode?" <Return↵>.

d. An MS-DOS window appears displaying this syntax, C:\Windows>_.

e. Change directories; type CD.. and press <Return↵>.

f. New syntax appears, C:\>_.

g. Type LOG and press <Return↵> to invoke the CASASII Main Menu screen.

h. The CASASII Main Menu appears with twelve commands labeled F1-F12. The current File Header and Data Directory are also displayed.

i. Press <CTRL+T> to disable the automated alarms. The LOG program makes a statement on the screen "Alarms Off."

3.2 Make a New or Select an Existing Data Directory

3.2.1 From the CASASII Main Menu, press **F6** – *File/Directory Commands*. (The File/Directory screen appears with six commands labeled F1-F6.)

a. Option 1:
- Press **F1** – *Set Default Data Directory*. Select a directory that already exists. A list of directories that LOG can invoke appears. Use the <Arrow Keys> to select a directory, press the keyboard <Spacebar> to invoke it.

b. Option 2:
- Press **F3** – *Make Data Directory*. Create a new directory. Enter a directory name up to 8 characters. The LOG program automatically adds the directory suffix extension <*.DIR> <Return↵>.
- Press **F1** – *Set Default Data Directory*. Select the new directory created from the above step using the <Arrow Keys>, press the keyboard <Spacebar> to invoke it.

c. Press <ESC> to return to the CASASII Main Menu. Observe that the selected Data Directory name appears on the screen.

3.3 SGLS Set Up and Borehole Information

3.3.1 From the CASASII Main Menu:

a. Press **F8** – *Load Initialization Defaults*. A list of initialization files that LOG can invoke appears.

b. Select <SGLS.INI> using the <Arrow Keys> and press the <Spacebar> to invoke it. This will load the correct 921-MCB setup, check the 973-amplifier settings. The CASASII Main Menu reappears.

c. Press **F1** – *LOG Initialization*. A 16-field initialization screen appears, which contains a default profile of values for the SGLS set up. The LOG program will prompt an Y/N response to edit entries. Enter yes (Y) and edit the fields as necessary, include a new File Header name. <Return↵>.

d. Press <ESC> to return to the CASASII Main Menu.

e. A check mark (✓) will appear to the right of **F1** - *LOG Initialization* indicating the data was successfully completed.

- Option: Press **F9** – *Save Initialization Defaults*. Save this edited initialization file, if this set up profile is going to be used again in the future. A prompt box appears for a new file name and automatically adds the suffix extension <*.INI> <Return↵>.

3.4 Detector Pre Calibration And System Warm-Up

3.4.1 From the CASASII Main Menu:

a. Press **F2** – *Detector Calibration*. The Calibration Screen appears with a graphical area for displaying spectral data in units of channels. Across the bottom, the screen has twelve function keys to input values, expand scale, and move two cursor pointers labeled F1-F12.

b. Press **F3** – *Real Time* and enter **1,000** seconds for HPGe detectors of 35% or less of relative efficiency, or **500** seconds for detectors of greater than 35% relative efficiency. Press <Return↵>.

c. Press **F5** – *Start/Stop* to begin acquiring a spectrum.

d. Start the **30-minute** warm up period and note the time in the field logbook. Proceed with the fine-gain adjustment.

3.5 Fine Gain Adjustment

3.5.1 From the Calibration Screen: The 921-MCB is set up to stabilize the1461-keV gamma-ray peak on the graphical display between channels 2120 and 2130. If gain drift has occurred or if a different sonde has been previously employed, the 973-amplifier may need adjustment to meet the set up parameter.

a. Wait **10 to 15 minutes** while the instruments in the equipment rack warm up.

b. Press **F10** – *Clear* to restart collecting a spectrum during warm-up.

c. Press **F12** – *Scale* while acquiring a calibration spectrum to display a new set of function keys that can zoom in and out and pan across the graphical display.

d. Press **F1** - *<X1>* to expand scale and **F2** – *X1>>* to pan across the graphical display to the 1461-keV gamma-ray peak (if MCA 1 is employed). Press **F3** - <X2> and **F4** - <X2> to perform similar functions if MCA 2 is employed.

e. Press **F12** – *Return*. Return to the previous set of Scale controls.

f. Press **F11** - *Cur1a/Cur1b/Cur2a/Cur2b* and toggle to the cursor labeled **Cur1b**. Align cursor **Cur1b** over the centroid of the 1461-keV gamma-ray peak at about channel 2125. Note the Cur1b/1461-centroid channel number displayed on the screen.

g. If necessary, rotate the pot labeled "fine gain" a few units on the 973-amplifer until the Cur1b/1461-centroid align. Note the channel number.

h. Press **F5** – *Start/Stop* or **F10** – *Clear* to restart collecting a spectrum. After adjusting the fine gain note if the Cur1b/1461-centroid align and the channel number.

i. Repeat the above steps until the Cur1b/centroid align. Gain drift usually stops after about 15 minutes.

j. Press **F11** - *Cur1a/Cur1b/Cur2a/Cur2b* and toggle to the cursor labeled **Cur1a**. Align cursor **Cur1a** over the centroid of the 583-keV gamma-ray peak at about channel 850. Note the Cur1a/583-centroid channel number displayed on the screen.

k. After the **30-minute** warm up period expires and the fine gain adjustments made, collect a calibration spectrum and note the time in the field logbook.

l. Press **F10** – *Clear* again and collect a verification spectrum for the full **1,000 or 500** seconds.

3.6 Two-Point Calibration and Save

3.6.1 From the Calibration Screen: After a calibration spectrum is collected, align cursors **Cur1a** and **Cur1b** over the centroid of the **583.2**-keV gamma-ray peak (about channel 850) and **2614.5**-keV gamma-ray peak (about channel 3805), respectively.

a. Press **F1** – *Calibration*. Enter the following energy values in the LOG prompt boxes, **583.2** and **2614.5**. <Return↵>.

b. Press **F7** – *Precal/Postcal/Prebak/Postbak* and toggle to **Precal**.

c. Press **F6** – *Save*. Saves the calibration spectra to the default data directory. The LOG program automatically adds the file name extension <*CAB.CHN>

d. On the calibration screen, the LOG program prompts "Saved Data, Hit Any Key."

e. Note that the graphical area is now calibrated in units of energy (keV).

f. Press **F9** – *Channel*. Toggle between units of channel and energy to check settings.

g. Press <ESC> to return to the CASASII Main Menu.

h. A check mark (✓) will appear to the right of **F2** – *Detector Calibration*, indicating the data was successfully completed.

3.7 Analyze Spectrum and Compare Results to Acceptance Criteria

3.7.1 Analyze the pre-calibration spectrum and compare the results to acceptance criteria.

a. Copy the pre-calibration file <*CAB.CHN> to the laptop computer for analysis.

b. See the desktop instructions for analyzing Field Verification Spectra and the most recent published acceptance criteria to complete this step in the guide.

3.8 Log Data Sheet and Stow KUTh Check-Source

3.8.1 If the logging engineer's professional judgment indicates that the SGLS is ready to log, then he/she will do the following:

a. Fill out the appropriate spaces on the Log Data Sheet.

b. Make a note in the field logbook that the verification spectrum has met the acceptance criteria.

c. Place the KUTh check-source in the storage compartment, secure, and lock it.

d. Position the **centralizer** on the sonde when logging boreholes greater than or equal to 6-in in diameter.

e. If needed, install logging accessories such as the tungsten shield or plastic wrap.

3.9 Zero-Depth Reference and Setting Initial Depth

The zero-depth reference on the sonde is a scribe line marked around the bottom of the turned-down section of the housing. The zero-depth reference for a borehole is usually the top of the casing, but the ground surface or other reference is acceptable.

3.9.1 Note the borehole's zero-depth reference on the Log Data Sheet.

3.9.2 Place the sonde in the borehole.

3.9.3 Release the hoist brake on the OC.

3.9.4 Use the joystick and align the zero-depth references for both the sonde and borehole.

3.9.5 Reset the depth counter on the OC to 0.00 ft.

3.9.6 Note the LN2 flow in the field logbook.

3.10 Depth Control

3.10.1 From the CASASII Main Menu:

a. Press **F3** – *Depth Control*. The Depth Control screen appears with four commands labeled F1-F4.

b. Press **F2** – *Enter*. Enter values for borehole and sonde depth. <Return↵>.

c. A Y/N prompt box appears - move the detector to a new depth? A yes (Y) answer will request a depth be entered; <Return↵>; followed by a second prompt - what speed should the hoist should move the sonde? Enter a value (between 1-30 ft/min), <Return↵>. The LOG program automatically starts moving the sonde to the new depth. A no (N) answer will return to the CASASII Main Menu.

d. As the sonde moves, the Depth Control screen and OC both display current depth. Use the Depth Control screen as true depth. The display depth on the OC is only a back-up and is not as accurate.

e. When starting depth is reached, use the joystick, move the sonde to the nearest 0.5 ft, and record the starting depth on the Log Data Sheet and field logbook.

f. Press <ESC> to return to the CASASII Main Menu.

g. A check mark (✓) will appear to the right of **F3** – *Depth Control*, indicating the data was successfully completed.

3.11 Acquire Spectra and Begin Logging

3.11.1 From the CASASII Main Menu:

a. Press **F4** – *Acquire Spectra*. The Acquire Screen appears. This command may only be invoked if data were successfully completed for *Log Initialization* (F1), *Detector Calibration* (F2), and *Depth Control* (F3), which are indicated by a check mark (✓) to the right of each title. Proceed with data acquisition parameters. These parameters will be specified in the Logging Request & Tracking Sheet.

b. Press **F1** – *Move-Stop-Acquire*. Input a depth increment (usually 1.0 ft), counting time (usually **100 sec. real time**), and a stop logging depth. These logging parameters will be specified on the Logging Request and Tracking Sheet provided for each borehole.

c. Press <Return↵>. The software controlled log run starts. The LOG program automatically adds the file suffix <*.CHN> and sequentially numbers the data files.

3.11.2 From the Instrument Cabin, monitor the following operations during logging:

a. Spectrum collection.

b. Adjust gain stabilization as required and record those adjustments on the Log Data Sheet. List the affected depth and file number.

c. Make entries as necessary on the Log Data Sheet and in the field logbook.
- LN2 flow
- Hydraulic fluid pressure
- Strain pressure
- Hydra-Gen® power output
- HV1 remains ON
- UPS power output
- Engine tachometer
- Engine gauges
- Hoist operation
- Crane position

3.12 Ending a Log Run and Moving the Sonde

3.12.1 From the Acquire Spectra window: When the sonde reaches the stop depth, the LOG program automatically terminates the data acquisition process. The **F4** - *Acquire Spectra* window remains open, waiting on stand-by.

a. Record on the Log Data Sheet the last file number recorded and the corresponding depth achieved. All this information is found on the final spectra file.

b. Press <ESC> to open to the CASASII Main Menu.

c. If a Repeat Log Run is required, proceed to that section now, if not continue.

d. Press **F3** – *Depth Control*. The depth control screen appears.

e. Press **F5** - *Move*. A prompt box appears - move the detector to a new depth? A Y (yes) answer will request a depth be entered; <Return↵>; followed by a second prompt - what speed should the hoist should move the sonde? Enter a value (1-30 ft/min), <Return↵>. The LOG program automatically starts moving the sonde to the new depth.

f. Press <ESC> to open to the CASASII Main Menu.

3.13 Check the Zero-Depth Reference

3.13.1 After the sonde has returned to 00.0 ft, record on the Log Data Sheet the discrepancy between the original and return zero-depth references.

a. Option 1:
- Logging will continue with a new log run, a Repeat Log Run, or changing locations. Change file name as appropriate, move to new depth, and acquire data.

b. Option 2:
- Logging is finished for the day; proceed with collecting a post calibration spectrum.
- Remove the KUTh verifier from the storage compartment and position the sonde.

3.14 Post Calibration Spectrum

3.14.1 From the CASASII Main Menu:

a. Press **F2** – *Detector Calibration*. The calibration screen appears.

b. Press **F3** – *Real Time* and enter **1,000** seconds for HPGe detectors of 35% or less of relative efficiency, or **500** seconds for detectors of greater than 35% relative efficiency. <Return↵>.

c. Press **F5** – *Start/Stop* to begin acquiring a spectrum.

d. Do **not** make any fine gain adjustments; acquire a spectrum until time elapses.

e. Press **F7** – *Precal/Postcal/Prebak/Postbak* and toggle to **Postcal**.

f. Press **F6** – *Save*. Saves the calibration spectra to the default data directory. The LOG program automatically adds the file name extension <*CAA.CHN>

g. On the calibration screen, the LOG program prompts "Saved Data, Hit Any Key."

h. Press <ESC> to return to the CASASII Main Menu.

3.15 Exit CASASII LOG Program

3.15.1 Press <ESC> on the keyboard while the CASASII Main Menu is open.

3.15.2 The LOG program prompts an Y/N box – Do you wish to quit now?

3.15.3 Press yes (Y) to close CASASII Main Menu and exit to the MS-DOS window.

3.15.4 This syntax appears, C:\LOG>_.

3.15.5 Type "EXIT." <Return↵>. "Windows is starting" appears.

3.16 Transfer Data Files and Shut Down Logging Computer

3.16.1 Copy the set of spectra files just collected from the logging computer to the mass storage device. Transfer this data, the Log Data Sheets, the Data Tracking Record, and the Logging Request and Tracking Sheet to the office for storage and analysis.

3.16.2 Complete and sign the Log Data Sheet(s), and complete entries in the field logbook and sign and date the appropriate page(s).

3.16.3 Complete and initial the Data Tracking Record.

3.16.4 Complete appropriate sections and sign the Logging Request & Tracking Sheet.

3.16.5 Press <CTRL+ESC> on the Windows 95 desktop to display the Start Menu.

3.16.6 Use the <Arrow Keys> and move to "Shut Down . . ." <Return↵>.

3.16.7 Wait for Windows 95 to shut down.

3.16.8 Turn OFF the power switch for the logging computer.

3.16.9 Turn OFF the HV1 toggle switch.

3.16.10Turn OFF the NIM Bin power switch.

3.17 Equipment Rig Down

3.17.1 Stow and lock the KUTh verifier in the storage compartment.

3.17.2 Remove the sonde from the cable head, stow the sonde in the tray, and attach the LN2 dispensing system. Turn the LN2 ON.

3.17.3 Remove the sheave wheel from the crane and stow the logging cable.

3.17.4 Drop the hoist compartment drape and secure.

3.17.5 Break down the crane, fold the boom into traveling position, and secure.

3.17.6 Lift the outriggers and stow the pads.

3.17.7 Stow portable stairs and secure.

3.17.8 Close the Hydra-Gen® compartment door and secure.

3.17.9 Perform the Power Up, Power Down Sequence (Chapter 4.0) to finish.

3.17.10 Safety: Walk around the vehicle and make a final equipment check before moving away from the borehole.

4.0 Decontamination

As directed in the RWP or other project documentation, the logging cable and sonde may be wiped and surveyed as they are withdrawn from the borehole(s). If contamination is detected, the site radiological controls organization will direct decontamination of the affected components.

5.0 Waste Disposal

All waste generated during the execution of this procedure will be handled, packaged, labeled and disposed of in accordance with specific site requirements listed in project waste plans and/or other project documentation. The Project Coordinator will determine these requirements and provide the Logging Engineer specific waste disposal instructions on the Logging Request & Tracking Sheet. Waste generated may include, but is not limited to dirty rags from wiping the tools and cable as they are extracted from the borehole(s), and absorbent towels and plastic used to control small engine oil, hydraulic fluid and/or coolant leaks. All equipment will be maintained in good operating condition to prevent and/or minimize releases to the environment.

6.0 References

Greenspan, 1994, *Computer Automated Spectral Acquisition System II (CASASII) User Manual*, Greenspan, Inc., Houston, Texas.

U.S. Department of Energy (DOE) 2003. *Hanford Geophysical Logging Project Data Analysis Manual*, prepared for the U.S. Department of Energy by the S. M. Stoller Corporation, GJO-HGLP 1.6.3, Rev. 0, Richland, WA.

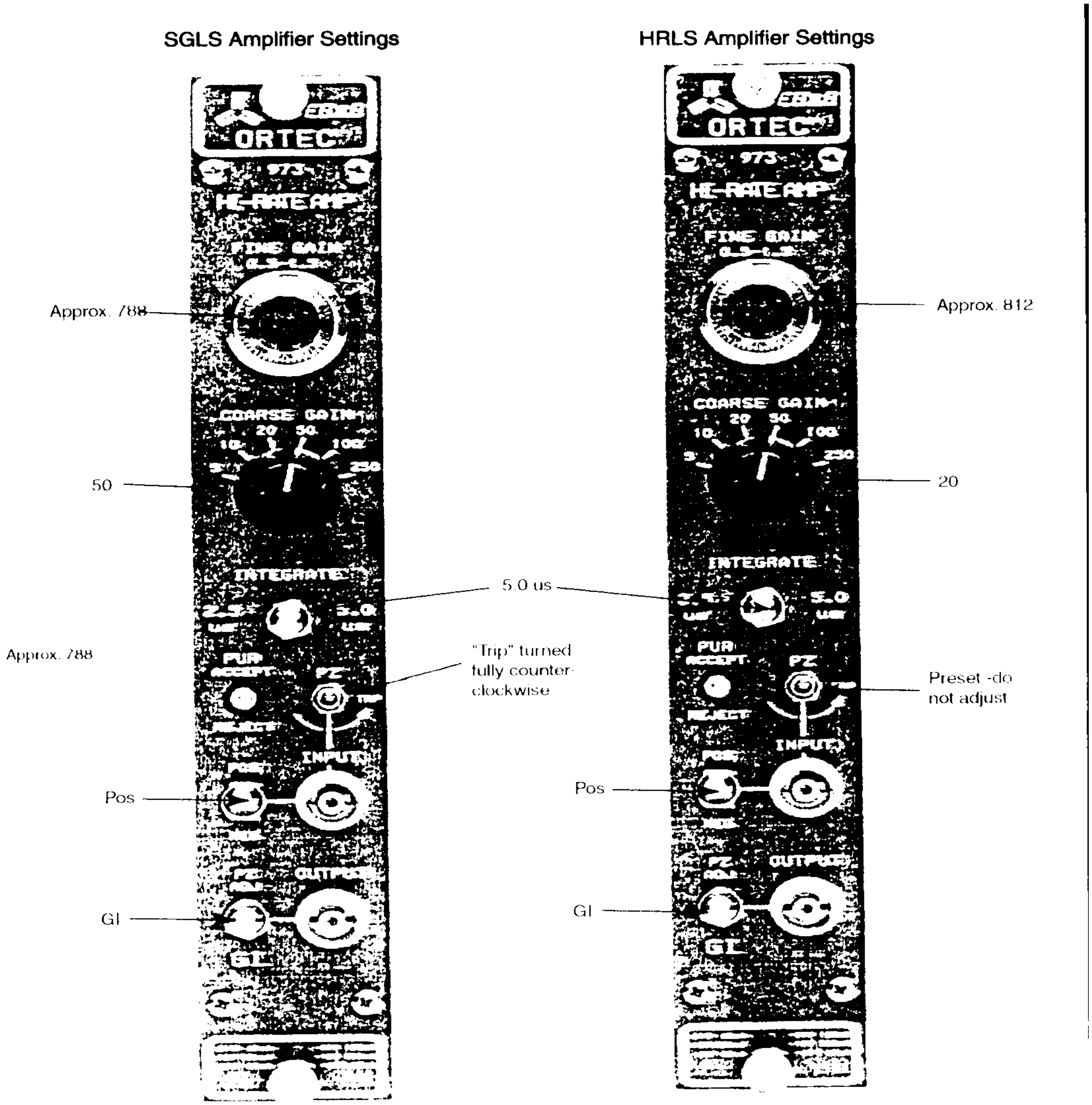

Figure 5-1. 973 Amplifier Settings

Prepared By:

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Alan W. Pearson S. M. Stoller Corp., Hanford Office	Date

Approved By:

Brian W. Mathis, Manager S. M. Stoller Corp., Hanford Office	Date

1.0 Purpose and Scope

This procedure provides the guidelines for conducting high rate gamma-ray logging (HRLS). HRLS logging is conducted through depth intervals in boreholes were the gamma-ray flux is such that the dead time encountered during SGLS logging exceeded 50 percent dead time.

2.0 Responsibilities

2.1 Stoller Geophysical Logging Project Manager

2.1.1 The Project Manager is responsible for ensuring all personnel using this procedure have been provided the appropriate training required to perform this procedure.

2.1.2 The Project Manager is responsible for approving this procedure.

2.2 Project Coordinator

2.2.1 The Project Coordinator is responsible for providing updates to this procedure and ensuring copies of this procedure are maintained on each logging vehicle.

2.2.2 The Project Coordinator is responsible for communicating to the Logging Engineer all applicable information required to perform this procedure including, but not limited to the well construction information, logging parameters and waste disposal instructions. This information will be communicated through the use of Logging Request and Tracking Sheets.

2.3 Geophysical Logging Engineer

2.3.1 The Geophysical Logging Engineer is responsible for performing this procedure and providing the Project Coordinator with feedback to update the procedure when necessary.

3.0 Procedure

This procedure assumes that the following assumptions are met:

- Gamma 1 is the vehicle being employed to acquire high rate data.
- The planar HPGe detector is connected.
- The *Vehicle Preparation Procedure* (Chapter 2.0) is complete.
- The *Borehole Set Up Procedure* (Chapter 3.0) is complete.
- The *Power Up, Power Down Sequence* (Chapter 4.0) is complete.
- The HRLS detector/container is aligned in the 200-µCi 137Cs calibration check-source.
- HV1 is ON and LN_2 is flowing.
- The settings on the HRLS 973-amplifier match Figure 6-1.

The steps outlined below demonstrate just one method of setting up the CASASII LOG program for acquiring HRLS data. Use these steps as a guide to become familiar with the CASASII LOG program. For more detail, consult the *CASASII LOG User's Manual* (Greenspan 1994).

General keyboard strokes are listed below to maneuver through the CASASII LOG program.

- Pressing <ESC> returns the user to the CASASII Main Menu.
- Pressing <ALT+Arrow Key Right/Left> moves the cursors 20 channels.
- Pressing <CTRL+Arrow Key Right/Left> moves the cursors 200 channels.

3.1 Invoke the CASASII LOG Program

3.1.1 Start from the Windows 95 desktop screen and restart in MS-DOS mode by performing the following keyboard stokes:

a. Press <CTRL+ESC> to display the Windows Start Menu.

b. Point to "Shut Down . . ." using <Arrow Keys> and Press <Return↵>.

c. Use the <Arrow Keys> and move to "Restart the computer in MS-DOS mode?" <Return↵>.

d. An MS-DOS window appears displaying this syntax, C:\Windows>_.

e. Change directories; type CD.. and press <Return ↵>.

f. New syntax appears, C:\>_.

g. Type LOG and press <Return↵> to invoke the CASASII Main Menu.

h. The CASASII Main Menu appears with twelve commands labeled F1-F12. The current File Header and Data Directory are also displayed.

i. Press <CTRL+T> to disable the automated alarms. The LOG program makes a statement on the screen "Alarms Off."

3.2 Make a New Data Directory or Select an Existing Data Directory

3.2.1 From the CASASII Main Menu

a. Press **F6** - *File/Directory Commands*. The File/Directory screen appears with six commands labeled F1-F6.

b. Option 1:
- Press **F1** – *Set Default Data Directory*. A list of directories that LOG can invoke appears. Use the <Arrow Keys> to select a directory, press the keyboard <Spacebar> to invoke it.

c. Option 2:
- Press **F3** – *Make Data Directory*. Create a new directory. Enter a directory name up to 8 characters. The LOG program automatically adds the directory suffix extension <*.DIR> <Return↵>. Press **F1** – Set Default Data Directory. Select the new directory created from the above step using the <Arrow Keys>, press the keyboard <spacebar> to invoke it. Go to Step D.

d. Press <ESC> to return to the CASASII Main Menu. Observe that the selected Data Directory name appears on the screen.

3.3 HRLS Set Up And Borehole Information

3.3.1 From the CASASII Main Menu:

a. Press **F8** – *Load Initialization Defaults*. A list of initialization files that LOG can invoke appears.

b. Select <HRLS.INI> using the <Arrow Keys> and press the <Spacebar> to invoke it. The CASASII Main Menu reappears.

c. Press **F1** – *LOG Initialization*. A 16-field initialization screen appears, which contains a default profile of values for the HRLS set up. The LOG program will prompt an Y/N response to edit entries. Answer yes (Y) and edit the fields as necessary, include a new File Header name. <Return↵>.

d. Press <ESC> to return to the CASASII Main Menu.

e. A check mark (✓) will appear to the right of F1 - Log Initialization, indicating the data was successfully completed.

- Option: Press **F9** – *Save Initialization Defaults*. (Optional). Save this edited initialization file, if this set up profile is going to be used again in the future. A prompt box appears for a new file name and automatically adds the suffix extension <*.INI> <Return↵>.

3.4 Detector Pre Calibration And System Warm-Up

3.4.1 From the CASASII Main Menu:

a. Press **F2** – *Detector Calibration*. The Calibration Screen appears with a graphical area for displaying spectral data in units of channels. Across the bottom, the screen has twelve function keys to input values, expand scale, and move two cursor pointers labeled F1-F12.

b. Press **F3** – *Real Time* and enter **1,000** seconds. <Return↵>.

c. Press **F5** – *Start/Stop* to begin acquiring a spectrum.

d. Start the **30-minute** warm up period and note the time in the field logbook. Proceed with the fine-gain adjustment.

3.5 Fine-Gain Adjustment

3.5.1 From the Calibration Screen: The 921-MCB is not set up to stabilize any gamma-ray peaks on the graphical display when acquiring HRLS data. A fine gain adjustment is made to center the 662-keV gamma-ray peak at approximately channel 1019.

a. Wait **15 minutes** while the instruments in the equipment rack warm up.

b. Press **F10** – *Clear* to restart collecting a spectrum during warm up.

c. Press **F12** – *Scale*. A new set of function keys are displayed that can zoom in and out and pan across the graphical display.

d. Press **F1** - *<X1>* to expand scale and **F2** – *X1>>* to pan across the graphical display to the 662-keV gamma-ray peak.

e. Press **F12** – *Return*. Return to the previous set of Scale controls.

f. Press **F11** - *Cur1a/Cur1b/Cur2a/Cur2b* and toggle to the cursor labeled **Cur1a**. Move cursor **Cur1a** to channel 1019.

g. If necessary, rotate the pot labeled “fine gain” a few units on the 973-amplifer labeled HRLS until the Cur1a/662-centroid align. Note the channel number.

h. Press **F5** – *Start/Stop* or **F10** – *Clear* to restart collecting a spectrum. After adjusting the fine gain note if the Cur1a/662-centroid align and the channel number.

i. Repeat the above steps until the Cur1a/662-centroid align. Gain drift usually occurs when the power is first applied and stops after about 15 minutes.

j. Remove the cursors off the screen and note the total count rate. A properly aligned detector/container will detect a total count rate of approximately **800** counts per second.

k. After the **30-minute** warm up period expires and the fine gain adjustments made, collect a calibration spectrum and note the time in the field logbook.

l. Press **F10** – *Clear* again and collect a verification spectrum for the full **1,000 seconds**.

3.6 Two-Point Calibration and Save

3.6.1 From the Calibration Screen: After a calibration spectrum is collected, align cursor **Cur1a** over the centroid of the **661.7**-keV gamma-ray peak at channel **1019**. Move cursor **Cur1b** over the centroid of **1332.5**-keV gamma-ray peak at channel **2046**. Note the 1333-keV peak will not appear during the calibration. For this step in the procedure channel 2046 is a placeholder and was determined by experiment when the HRLS base calibration was conducted.

a. Press **F1** – *Calibration*. Enter the following energy values in the LOG prompt boxes, **661.7** and **1332.5**. <Return↵>.

b. Press **F7** – *Precal/Postcal/Prebak/Postbak* and toggle to **Precal**.

c. Press **F6** – *Save*. Saves the calibration spectra to the default data directory. The LOG program automatically adds the file name extension <*CAB.CHN>

d. On the calibration screen, the LOG program prompts “Saved Data, Hit Any Key.”

e. Note that the graphical area is now calibrated in units of energy or keV.

f. Press **F9** – *Channel*. Toggle between units of channel and energy to check settings.

g. Press <ESC> to return to the CASASII Main Menu.

h. A check mark (✓) will appear to the right of **F2** – *Detector Calibration*, indicating the data was successfully completed.

3.7 Analyze the Pre Calibration Spectrum and Compare the Results to Acceptance Criteria

3.7.1 Copy the pre calibration file <*CAB.CHN> to the laptop computer for analysis.

3.7.2 See the desktop instructions for analyzing High Rate Field Verification Spectra and the most recent published acceptance criteria to complete this step in the guide.

3.8 Log Data Sheet and Stow the 200-µCi ^{137}Cs Check-Source

3.8.1 If the logging engineer's professional judgment indicates that the HRLS is ready to log, then he/she will do the following.

a. Fill out the appropriate spaces on the Log Data Sheet.

b. Make a note in the field logbook that the verification spectrum passed the acceptance criteria.

c. Slide the 200-µCi ^{137}Cs check-source into the storage compartment, secure, and lock.

d. Position the **centralizer** on the sonde when logging boreholes greater than or equal to 6-in in diameter.

e. If needed, install logging accessories such as the tungsten shield or plastic wrap.

3.9 Zero-Depth Reference and Setting Initial Depth

3.9.1 The zero-depth reference on the sonde is a scribe line marked around the bottom of the turned-down section of the housing. The zero-depth reference for a borehole is usually the top of the casing, but the ground surface or other reference is acceptable.

a. Note the borehole's zero-depth reference on the Log Data Sheet.

b. Place the sonde in the borehole.

c. Release the hoist brake on the OC.

d. Use the joystick and align the zero-depth references for both the sonde and borehole.

e. Reset the depth counter on the OC to 0.00 ft.

f. Note the LN2 flow in the field logbook.

3.10 Depth Control

3.10.1 From the CASASII Main Menu:

a. Press **F3** – *Depth Control*. The Depth Control screen appears with four commands labeled F1-F4.

b. Press **F2** – *Enter*. Enter values for borehole and sonde depth. <Return>.

c. A Y/N prompt box appears - move the detector to a new depth? A yes (Y) answer will request a depth be entered; <Return↵>; followed by a second prompt - what speed should the hoist should move the sonde? Enter a value (between 1-30 ft/min), <Return↵>. The LOG program automatically starts moving the sonde to the new depth. A no (N) answer will return to the CASASII Main Menu.

d. As the sonde moves, the Depth Control screen and OC both display current depth. Use the Depth Control screen as the true depth. The display on the OC is only a back-up and is not as accurate.

e. When starting depth is reached, use the joystick, move the sonde to the nearest 0.5 ft, and record the starting depth on the Log Data Sheet.

f. Press <ESC> to return to the CASASII Main Menu.

g. A check mark (✓) will appear to the right of **F3** – *Depth Control*, indicating the data was successfully completed.

3.11 Acquire Spectra and Begin Logging

3.11.1 From the CASASII Main Menu:

a. Press **F4** – *Acquire Spectra*. The Acquire Screen appears. This command may only be invoked if data were successfully completed for *Log Initialization* (F1), *Detector Calibration* (F2), and *Depth Control* (F3), which are indicated by a check mark (✓) to the right of each title. Proceed with data acquisition parameters. These parameters will be specified in the Logging Request & Tracking Sheet.

b. Press **F1** – *Move-Stop-Acquire*. Input a depth increment (usually 1.0 ft), counting time (usually **300 sec. real time**), and a stop logging depth.

c. Press <Return↲>. The software controlled log run starts. The LOG program automatically adds the file suffix <*.CHN> and sequentially numbers the data files.

3.12 Logging Zones Of Extremely High Gamma Flux

3.12.1 If the dead time exceeds 50%, stop the log run.

3.12.2 Initiate a new log run and acquire data using **100-second real time**.

3.12.3 Overlap 1 ft and continue with a new log run.

3.12.4 Record changes on the Log Data Sheet.

3.12.5 From the Instrument Cabin, monitor the following operations during logging:

- Spectrum collection
- LN2 flow
- Hydraulic fluid pressure
- Strain pressure.
- Hydra-Gen® power output
- HV1 remains ON
- UPS power output
- Engine tachometer
- Engine gauges
- Hoist operation
- Crane position

a. Adjust fine gain as necessary keeping the 662-centroid at or near channel 1019. Record depth and file number if adjustments are made on the Log Data Sheet.

b. Make entries as necessary on the Log Data Sheet and logbook.

3.13 Ending a Log Run and Moving the Sonde

3.13.1 From the Acquire Spectra window: When the sonde reaches the stop depth, the LOG program automatically terminates the data acquisition process. The **F4** - *Acquire Spectra* window remains open, waiting on stand-by.

a. Record on the Log Data Sheet the last file number recorded and the corresponding depth. All this information is found on the final spectra file.

b. Press <ESC> to open to the CASASII Main Menu.

c. If a Repeat Log Run is required, proceed to that section now, if not continue.

d. Press **F3** – *Depth Control*. The depth control screen appears.

e. Press **F5** - *Move*. A prompt box appears - move the detector to a new depth? A Y (yes) answer will request a depth be entered; <Return↵>; followed by a second prompt - what speed should the hoist should move the sonde? Enter a value (1-30 ft/min), <Return↵>. The LOG program automatically starts moving the sonde to the new depth.

f. Press <ESC> to open to the CASASII Main Menu.

3.14 Check The Zero-Depth Reference

3.14.1 After the sonde has returned to 00.0 ft, record on the Log Data Sheet the discrepancy between the original and return zero-depth references.

a. Option 1:
- Logging will continue with a new log run, a Repeat Log Run, or changing locations. Change file name as appropriate, move to new depth or location, and acquire data.

b. Option 2:
- Logging is finished for the day; proceed with collecting a post calibration.
- Slide the 200-µCi ^{137}Cs calibration check-source from the storage compartment and align the detector/container.

3.15 Post Calibration Spectrum

3.15.1 From the CASASII Main Menu:

a. Press **F2** – *Detector Calibration*. The calibration screen appears.

b. Press **F3** – *Real Time* and enter **1,000** seconds. <Return↵>.

c. Press **F5** – *Start/Stop* to begin acquiring a spectrum.

d. Do not make fine gain adjustments - acquire a spectrum until time elapses.

e. Press **F7** – *Precal/Postcal/Prebak/Postbak* and toggle to **Postcal**.

f. Press **F6** – *Save*. Saves the calibration spectra to the default data directory. The LOG program automatically adds the file name extension <*CAA.CHN>

g. On the calibration screen, the LOG program prompts "Saved Data, Hit Any Key."

h. Press <ESC> to return to the CASASII Main Menu.

3.16 Exit CASASII LOG Program

3.16.1 Press <ESC> on the keyboard while the CASASII Main Menu is open.

3.16.2 The LOG program prompts an Y/N box – Do you wish to quit now?

3.16.3 Press Y (yes) to close CASASII Main Menu and exit to the MS-DOS window.

3.16.4 This syntax appears, C:\LOG>_.

3.16.5 Type EXIT. <Return↵>. "Windows is starting" appears.

3.17 Transfer Data Files And Shut Down The Logging Computer

3.17.1 Copy a set of spectra files from the logging computer to a mass storage device. These data, the Log Data Sheets, the Data Tracking Record, and the Logging Request & Tracking Sheet are all transferred to the office for storage and analysis.

3.17.2 Complete and sign the Log Data Sheet(s), complete entries in the field logbook, and sign and date the appropriate page(s).

3.17.3 Complete and initial the Data Tracking Record.

3.17.4 Complete appropriate sections and sign the Logging Request & Tracking Sheet.

3.17.5 Press <CTRL+ESC> on the Windows 95 desktop to display the Start Menu.

3.17.6 Use the <Arrow Keys> and move to “Shut Down . . .” <Return↵>.

3.17.7 Wait for Windows to shut down.

3.17.8 Turn OFF the power switch for the logging computer.

3.17.9 Turn OFF the HV1 toggle switch and the NIM Bin power switch.

3.18 Equipment Rig Down

3.18.1 Stow and lock the 200-µCi ^{137}Cs calibration check-source in the storage compartment.

3.18.2 Remove the sonde from the cable head, stow the sonde in the tray, and attach the LN2 dispensing system. Turn the LN2 ON.

3.18.3 Remove the sheave wheel from the crane and stow the logging cable.

3.18.4 Drop the hoist compartment drape and secure.

3.18.5 Break down the crane, fold the boom into traveling position and secure.

3.18.6 Lift the outriggers and stow the pads.

3.18.7 Stow portable stairs and secure.

3.18.8 Close the Hydra-Gen® compartment door and secure.

3.18.9 Perform the *Power Up, Power Down Sequence* (Chapter 4) to finish.

3.18.10 Safety: Walk around the vehicle and make a final equipment check before leaving the borehole.

4.0 Decontamination

As directed in the RWP or other project documentation, the logging cable and sonde may be wiped and surveyed as they are withdrawn from the borehole(s). If contamination is detected, the site radiological controls organization will direct decontamination of the affected components.

5.0 Waste Disposal

All waste generated during the execution of this procedure will be handled, packaged, labeled and disposed of in accordance with specific site requirements listed in project waste plans and/or other project documentation. The Project Coordinator will determine these requirements and provide the Logging Engineer specific waste disposal instructions on the Logging Request & Tracking Sheet. Waste generated may include, but is not limited to dirty rags from wiping the tools and cable as they are extracted from the borehole(s), and absorbent towels and plastic used to control small engine oil, hydraulic fluid and/or coolant leaks. All equipment will be maintained in good operating condition to prevent and/or minimize releases to the environment.

6.0 References

Greenspan, 1994, *Computer Automated Spectral Acquisition System II (CASASII) User Manual*, Greenspan, Inc., Houston, Texas.

U.S. Department of Energy (DOE) 2003. *Hanford Geophysical Logging Project Data Analysis Manual*, prepared for the U.S. Department of Energy by the S. M. Stoller Corporation, GJO-HGLP 1.6.3, Rev. 0, Richland, WA.

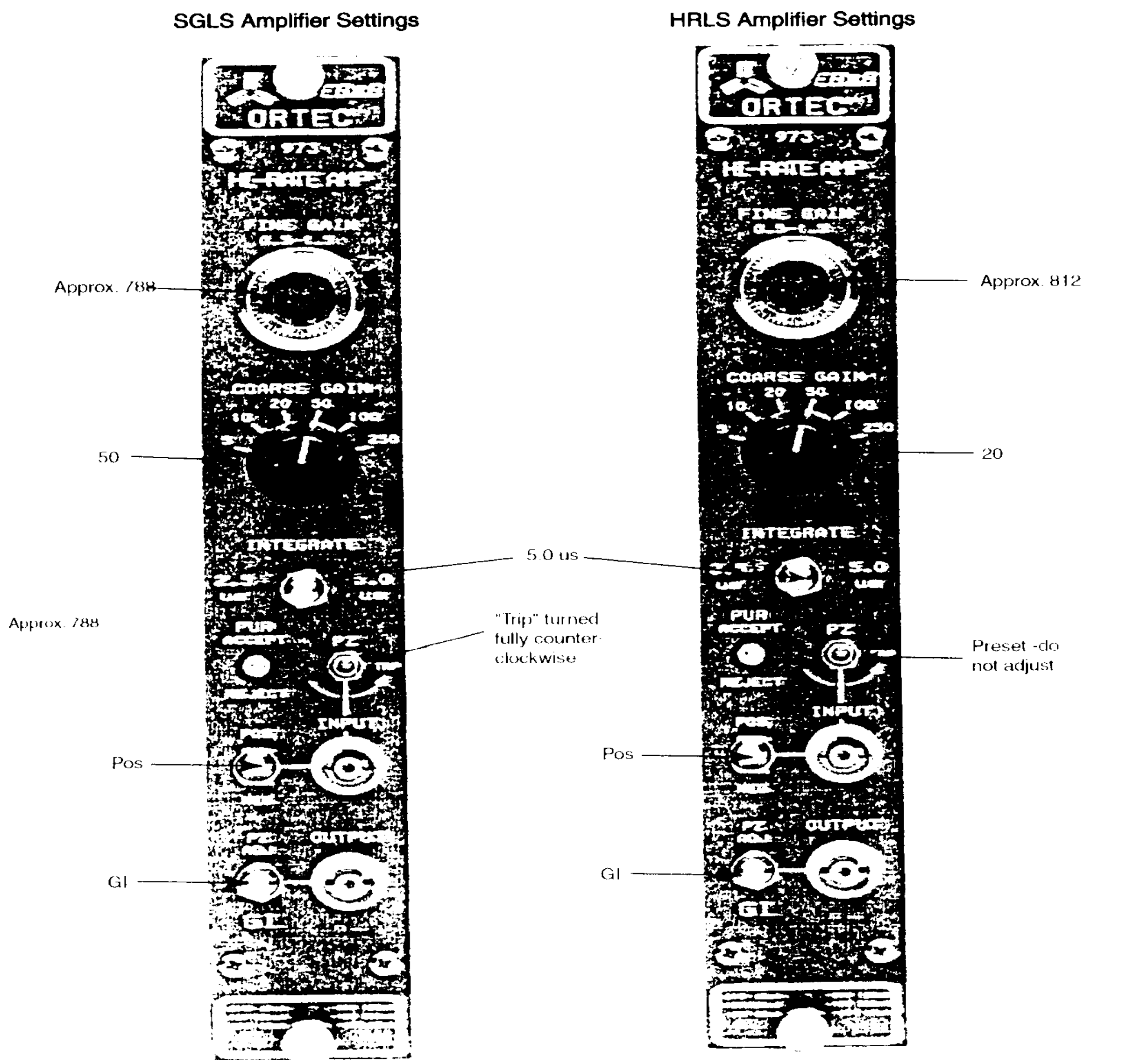

Figure 6-1. HRLS 973 Amplifier Settings

Chapter 7.0 Neutron Moisture Logging Procedure

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1.0 Purpose and Scope

This procedure provides the guidelines for conducting neutron moisture logging (NMLS). NMLS logging utilizes a neutron moisture gauge to measure volumetric percent moisture in the subsurface through borehole geophysical logging methods. This system is calibrated for standard 6-in and 8-in diameter carbon steel casing. The system can be used to provide qualitative moisture data in other sizes of casing.

2.0 Responsibilities

2.1 Stoller Geophysical Logging Project Manager

2.1.1 The Project Manager is responsible for ensuring all personnel using this procedure have been provided the appropriate training required to perform this procedure.

2.1.2 The Project Manager is responsible for approving this procedure.

2.2 Project Coordinator

2.2.1 The Project Coordinator is responsible for providing updates to this procedure and ensuring copies of this procedure are maintained on each logging vehicle.

2.2.2 The Project Coordinator is responsible for communicating to the Logging Engineer all applicable information required to perform this procedure including, but not limited to the well construction information, logging parameters and waste disposal instructions. This information will be communicated through the use of Logging Request and Tracking Sheets.

2.3 Geophysical Logging Engineer

2.3.1 The Geophysical Logging Engineer is responsible for performing this procedure and providing the Project Coordinator with feedback to update the procedure when necessary.

3.0 Procedure

This procedure assumes that the following assumptions are met:

- The *Vehicle Preparation Procedure* (Chapter 2.0) is complete.
- The *Borehole Set Up Procedure* (Chapter 3.0) is complete.
- The *Power Up, Power Down Sequence* (Chapter 4.0) is complete.
- The neutron moisture shield/calibration standard in ON the detector.
- The settings on the 672-amplifier match Figure 7-1 for Gamma 2.
- The settings on the 672-amplifier match Figure 7-2 for Gamma 4.

The steps outlined below demonstrate just one method of setting up the CASASII LOG program for acquiring neutron moisture data. Use these steps as a guide to become familiar with the CASASII LOG program. For more detail, consult the *CASASII LOG User's Manual* (Greenspan 1994).

General keyboard strokes are listed below to maneuver through the CASASII LOG program.

- Pressing <ESC> returns the user to the CASASII Main Menu.
- Pressing <ALT+Arrow Key Right/Left> moves the cursors 20 channels.
- Pressing <CTRL+Arrow Key Right/Left> moves the cursors 200 channels.

3.1 Invoke the CASASII LOG Program

3.1.1 Start from the Windows 95 desktop screen and restart in MS-DOS mode by performing the following keyboard stokes.

a. Press <CTRL+ESC> to display the Start Menu.

b. Point to "Shut Down . . ." using <Arrow Keys> and <Return↵>.

c. Use the <Arrow Keys> and move to "Restart the computer in MS-DOS mode?" <Return↵>.

d. An MS-DOS window appears displaying this syntax, C:\Windows>_.

e. Change directories; type CD.. and press <Return↵>.

f. New syntax appears, C:\>_.

g. Type LOG and <Return↵> to invoke the CASASII Main Menu screen.

h. The CASASII Main Menu appears with twelve commands labeled F1-F12. The current File Header and Data Directory are also displayed.

i. Press <CTRL+T> to disable the automated alarms. The LOG program makes a statement on the main menu screen "Alarms Disabled."

3.2 Make a New or Select an Existing Data Directory

3.2.1 From the CASASII Main Menu:

a. Press **F6** - *File/Directory Commands*. The File/Directory screen appears with six commands labeled F1-F6.

b. Option 1:
- Press **F1** – *Set Default Data Directory*. Select a directory that already exists. A list of directories that LOG can invoke appears. Use the <Arrow Keys> to select a directory, press the keyboard <Spacebar> to invoke it.

c. Option 2:

- Press **F3** – *Make Data Directory*. Create a new directory. Enter a directory name up to 8 characters. The LOG program automatically adds the directory suffix extension <*.DIR> <Return↵>.

- Press **F1** – *Set Default Data Directory*. Select the new directory created from the above step using the <Arrow Keys>, press the keyboard <Spacebar> to invoke it.

d. Press <ESC> to return to the CASASII Main Menu.

3.3 Neutron Moisture Initialization and Set Up

3.3.1 From the CASASII Main Menu:

a. Press F8 – *Load Initialization Defaults*. A list of initialization files that LOG can invoke appears.

b. Select <MOIST.INI> using the <Arrow Keys> and press the <Spacebar> to invoke it. This will load the correct 921-MCB and 672-amplifier settings. The CASASII Main Menu screen reappears.

c. Press F1 – *LOG Initialization*. A 16-field initialization screen appears, which contains a default profile of values for the neutron moisture set up. The LOG program will prompt an Y/N response to edit entries. Enter yes (Y) and edit the fields as necessary, include a new File Header name. <Return↵>.

d. Press <ESC> to return to the CASASII Main Menu.

e. A check mark (✓) will appear to the right of F1 - *LOG Initialization*, indicating the data was successfully completed.

f. Option:
- Press **F9** – *Save Initialization Defaults*. Save this edited initialization file if this set up profile is going to be used again in the future. A prompt box appears for a new file name and automatically adds the suffix extension <*.INI> <Return↵>.

3.4 Detector Pre Calibration and System Warm Up

3.4.1 From the CASASII Main Menu:

a. Press F2 – *Detector Calibration*. The Calibration Screen appears with a graphical area for displaying spectral data in units of channels. Across the bottom, the screen has twelve function keys to input values, expand scale, and move two cursor pointers.

b. Press F3 – *Real Time* and enter 100 seconds in the Acquire request. <Return↵>.

c. Press F5 – *Start/Stop*. Begin acquiring a spectrum. A single peak will appear on or about channel 255 and at or near 700 counts per second for Gamma 2 and 300 counts per second for Gamma 4.

d. Start the 15-minute warm up period and note the time in the field logbook. After 15 minutes, proceed with the fine-gain adjustment.

3.5 Fine-Gain Adjustment

3.5.1 From the Calibration Screen: A 512-channel spectrum should display the neutron moisture peak on or about channel 255. Check that a full spectrum is on the screen especially toward the lower channels that none is missing. If gain drift has occurred, then the 672-amplifier needs adjustment to meet this set up parameter.

3.5.2 Wait 15 minutes while the instruments in the equipment rack warm up.

3.5.3 Press F10 – *Clear*. Restart acquiring data when the acquisition time expires.

3.5.4 Press F12 – *Scale*. A new set of function keys are displayed that can zoom in and out and pan across the graphical display.

3.5.5 Press F3 - *<X2>* to expand scale and F4 – *X2>>* to pan across the graphical display to the neutron moisture peak.

3.5.6 Press F12 – *Return*. Return to the previous set of Scale controls.

3.5.7 Press F11 - *Cur1a/Cur1b/Cur2a/Cur2b*. Toggle to the cursor labeled Cur1b. Align cursor Cur1b over the centroid of the neutron peak at about channel 255. Note the Cur1b/neutron centroid channel number displayed on the screen.

3.5.8 If necessary, rotate the pot labeled "fine gain" a few units on the 672-amplifer until the Cur1b/neutron centroid align. Note the channel number.

3.5.9 Press F5 – *Start/Stop* or F10 – *Clear*. Restart collecting a spectrum. After adjusting the fine gain note if the Cur1b/neutron centroid align and the channel number.

3.5.10 Repeat the above steps until the Cur1b/centroid align. Gain drift usually occurs when the power is first applied and stops after about 15 minutes.

3.5.11 After the 15-minute warm up period expires and the fine gain adjustments made, collect a calibration spectrum and note the time in the field logbook.

3.5.12 Press F10 – *Clear*. Collect a calibration spectrum for the full 100 seconds.

3.6 From the Calibration Screen

3.6.1 An energy calibration is not assigned to the neutron spectrum. Verify that a full spectrum has been acquired and that the neutron spectrum has the expected shape.

3.6.2 Record the counts per second in the field logbook and compare with the acceptance criteria.

3.6.3 Press **F7** – *Precal/Postcal/Prebak/Postbak* and toggle to **Precal**.

3.6.4 Press **F6** – *Save*. Saves the calibration spectra to the default data directory. The LOG program automatically adds the file name extension <*CAB.CHN>

3.6.5 On the calibration screen, the LOG program prompts "Saved Data, Hit Any Key."

3.6.6 Press <ESC> to return to the CASASII Main Menu.

3.6.7 A check mark (✓) will not appear to the right of **F2** – *Detector Calibration* on the CASASII Main Menu.

3.7 Log Data Sheet and Stow the Shield/Calibration Standard

3.7.1 If the logging engineer's professional judgment indicates that the NMLS is ready to log, then he/she will do the following:

a. Fill out the appropriate spaces on the Log Data Sheet.

b. Remove the shield/calibration standard from the detector/source and secure it.

3.8 Zero-Depth Reference and Setting Initial Depth

The zero-depth reference on the sonde is a white line marked near the detector/neutron source near the bottom of the sonde. The zero-depth reference for a borehole is usually the top of the casing, but the ground surface or other reference is acceptable.

3.8.1 Note the borehole's zero-depth reference on the Log Data Sheet.

3.8.2 Place the sonde in the borehole.

3.8.3 Release the hoist brake on the OC.

3.8.4 Use the joystick and align the zero-depth references for both the sonde and borehole.

3.8.5 Reset the depth counter on the OC to 0.00 ft.

3.9 Depth Control

3.9.1 From the CASASII Main Menu:

a. Press **F3** – *Depth Control*. The Depth Control screen appears with four commands labeled F1-F4.

b. Press **F2** – *Enter*. Enter values for borehole and sonde depth. <Return↵>.

c. A Y/N prompt box appears - move the detector to a new depth? A yes (Y) answer will request a depth be entered; <Return↵>; followed by a second prompt - what speed should the hoist should move the sonde? Enter a value between 1-30 ft/min, <Return↵>. The LOG program automatically starts moving the sonde to the new depth. A no (N) answer will return to the CASASII Main Menu.

d. As the sonde moves, the Depth Control screen and OC both display current depth.

e. When starting depth is reached, use the joystick, move the sonde to the nearest 0.5 ft, and record the starting depth on the Log Data Sheet.

f. Press <ESC> to return to the CASASII Main Menu.

g. A check mark (✓) will appear to the right of F3 – Depth Control, indicating the data was successfully completed.

3.10 Acquire Spectra and Begin Logging

3.10.1 From the CASASII Main Menu:

a. Press **F4** – *Acquire Spectra*. The Acquire Screen appears. This command may only be invoked if data were successfully completed for *Log Initialization* (F1), *Detector Calibration* (F2), and *Depth Control* (F3), which are indicated by a check mark (✓) to the right of each title. Proceed with data acquisition parameters. The parameters will be specified on the Logging Request & Tracking Sheet.

b. Press **F1** – *Continuous*. A velocity and sample interval must be specified. Those inputs are usually 1-ft per minute and a 0.25-ft sample interval. Enter a stop depth. **Notes: 1) The detector is not watertight and should not be used below water. 2) No more than 400 files should be saved in any one directory. Change directories after every 100 ft of logging.**

c. Press <Return↵>. The software controlled log run starts. The LOG program automatically adds the file suffix <*.CHN> and sequentially numbers the data files.

3.10.2 From the Instrument Cabin monitor the following operations during logging:

- Spectrum collection
- Strain pressure
- Hydraulic fluid pressure
- Hydra-Gen® power output
- HV1 remains ON (subject to change)
- UPS power output
- Engine tachometer
- Engine gauges
- Hoist operation
- Crane position

3.10.3 Adjust fine gain as required and record those adjustments on the Log Data Sheet.

3.10.4 Make entries as necessary on the Log Data Sheet and in the field logbook.

3.11 Ending A Log Run And Moving The Sonde

From the Acquire Spectra window: When the sonde reaches the stop depth, the LOG program automatically terminates the data acquisition process. The **F4** - *Acquire Spectra* window remains open, waiting on stand-by.

3.11.1 Record on the Log Data Sheet the last file number recorded, and depth achieved. All this information is found on the final spectra file.

3.11.2 Press <ESC> to open to the CASASII Main Menu.

3.11.3 If a Repeat Log Run is required, proceed to that section now, if not continue.

3.11.4 Press **F3** – *Depth Control*. The depth control screen appears.

3.11.5 Press **F5** - *Move*. A prompt box appears - move the detector to a new depth? A Y (yes) answer will request a depth be entered; <Return↵>; followed by a second prompt - what speed should the hoist should move the sonde? Enter a value (1-30 ft/min), <Return↵>. The LOG program automatically starts moving the sonde to the new depth.

3.11.6 Press <ESC> to open to the CASASII Main Menu.

3.12 Check the Zero-Depth Reference

3.12.1 After the sonde has returned to 00.0 ft, record on the Log Data Sheet the discrepancy between the original and return zero-depth references.

3.12.2 Option 1:

- Logging will continue with a new log run, a Repeat Log Run, or changing locations. Change file name as appropriate, move to new depth, and acquire data.

3.12.3 Option 2:

- Logging is finished for the day; proceed with collecting a post calibration.

- Remove the shield/calibration standard from the storage compartment and attach it to the detector/source.

3.13 Detector Post Calibration Spectrum

3.13.1 From the CASASII Main Menu:

a. Press F2 – *Detector Calibration*. The calibration screen appears.

b. Press F3 – *Real Time* and enter 100 seconds. <Return↵>.

c. Press F5 – *Start/Stop* to begin acquiring a spectrum.

d. Do not make fine gain adjustments - acquire a spectrum until time elapses.

e. Press F7 – *Precal/Postcal/Prebak/Postbak* and toggle to Postcal.

f. Press F6 – *Save*. Saves the calibration spectra to the default data directory. The LOG program automatically adds the file name extension <*CAA.CHN>

g. On the calibration screen, the LOG program prompts “Saved Data, Hit Any Key.”

h. Press <ESC> to return to the CASASII Main Menu.

3.14 Transfer Data Files and Shut Down Logging Computer

3.14.1 Copy a set of spectra files from the logging computer to a mass storage device. Transfer this data, the Log Data Sheets, the Data Tracking Record, and the Logging Request & Tracking Sheet to the office for storage and analysis.

3.14.2 Complete and sign the Log Data Sheet(s).

3.14.3 Complete and initial the Data Tracking Record.

3.14.4 Complete appropriate sections and sign the Logging Request & Tracking Sheet.

3.14.5 Press <CTRL+ESC> on the Windows 95 desktop to display the Start Menu.

3.14.6 Use the <Arrow Keys> and move to “Shut Down . . .” <Return↵>.

3.14.7 Wait for Windows to shut down.

3.14.8 Turn OFF the power switch for the logging computer.

3.14.9 Turn OFF the NIM Bin power switch.

3.15 Equipment Rig Down

3.15.1 Remove the sonde from the cable head.

3.15.2 Remove the centralizer.

3.15.3 Remove the crossover sub from the detector/source/calibration standard.

3.15.4 Stow the detector/source/calibration standard in the instrument/storage case.

3.15.5 Stow and lock the neutron moisture gauge in the source compartment.

3.15.6 Remove the sheave wheel from the crane and stow the logging cable.

3.15.7 Drop the hoist compartment drape and secure.

3.15.8 Break down the crane, fold the boom into traveling position and secure.

3.15.9 Lift the outriggers and stow the pads.

3.15.10 Stow portable stairs and secure.

3.15.11 Close the Hydra-Gen® compartment door and secure.

3.15.12 Perform the *Power Up, Power Down Sequence* (Chapter 4.0).

3.15.13 Safety: Walk around the vehicle and make a final equipment check before leaving the borehole.

4.0 Decontamination

As directed in the RWP or other project documentation, the logging cable and sonde may be wiped and surveyed as they are withdrawn from the borehole(s). If contamination is detected, the site radiological controls organization will direct decontamination of the affected components.

5.0 Waste Disposal

All waste generated during the execution of this procedure will be handled, packaged, labeled and disposed of in accordance with specific site requirements listed in project waste plans and/or other project documentation. The Project Coordinator will determine these requirements and provide the Logging Engineer specific waste disposal instructions on the Logging Request and Tracking Sheet. Waste generated may include, but is not limited to dirty rags from wiping the tools and cable as they are extracted from the borehole(s), and absorbent towels and plastic used to control small engine oil, hydraulic fluid and/or coolant leaks. All equipment will be maintained in good operating condition to prevent and/or minimize releases to the environment.

6.0 References

Greenspan, 1994, *Computer Automated Spectral Acquisition System II (CASASII) User Manual*, Greenspan, Inc., Houston, Texas.

U.S. Department of Energy (DOE) 2003. *Hanford Geophysical Logging Project Data Analysis Manual*, prepared for the U.S. Department of Energy by the S. M. Stoller Corporation, GJO-HGLP 1.6.3, Rev. 0, Richland, WA.

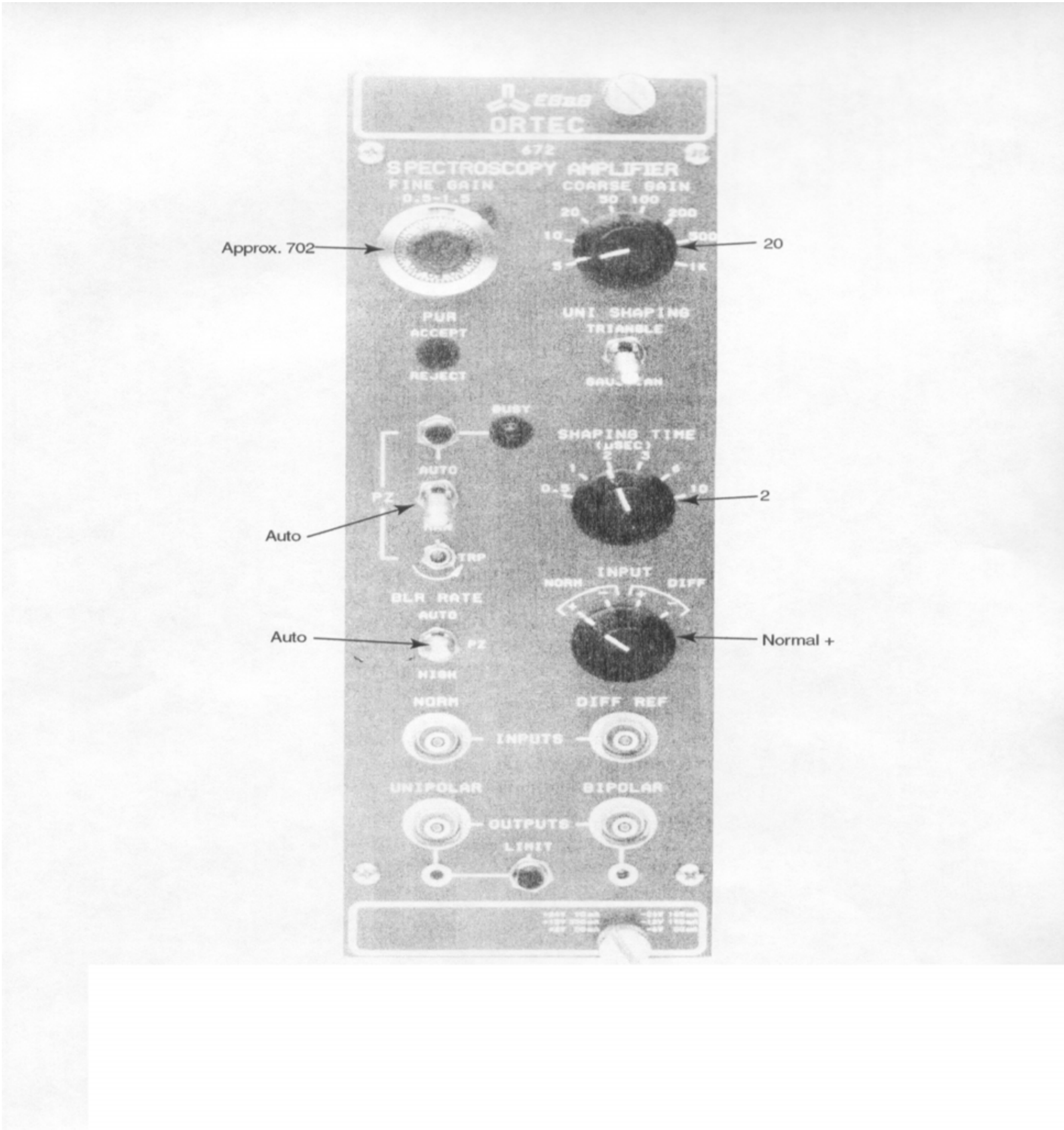

Figure 7-1. 672 Amplifier Settings for Sonde F

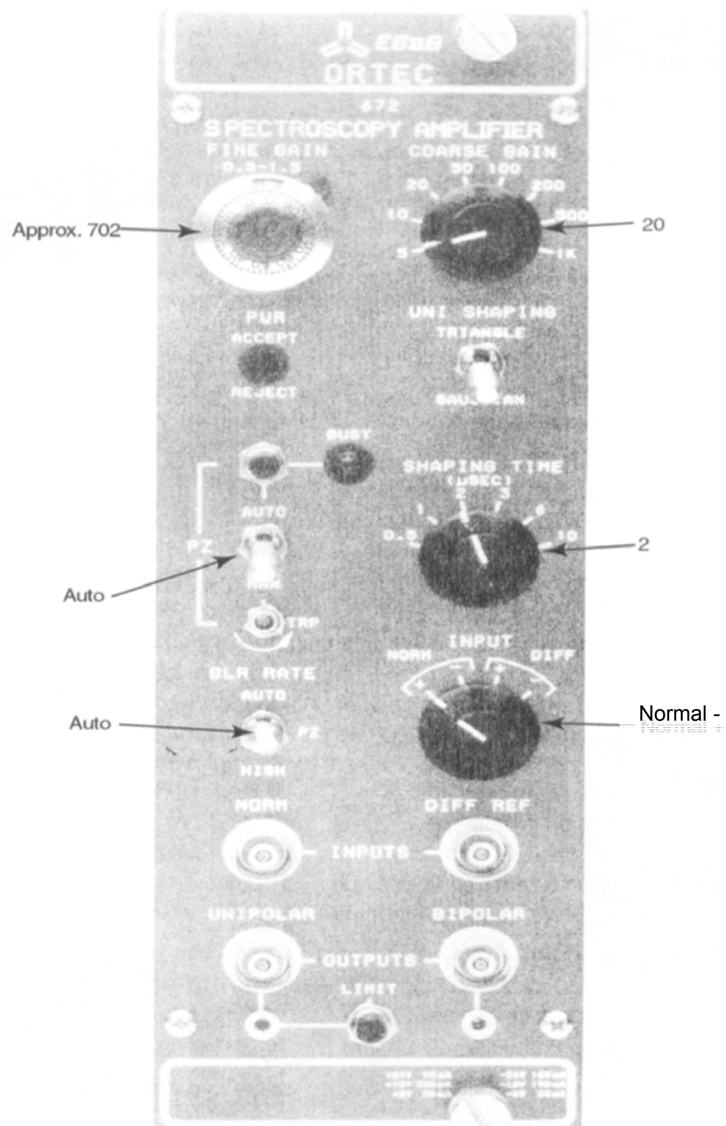

Figure 7-2. 672 Amplifier Settings for Sondes H and M

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S. M. Stoller Corp., Hanford Office

1.0 Purpose And Scope

This procedure provides the guidelines for conducting passive neutron logging using an Helium-3 detector. This tool is not calibrated and is used only for qualitative measurements.

2.0 Responsibilities

2.1 Stoller Geophysical Logging Project Manager

2.1.1 The Project Manager is responsible for ensuring all personnel using this procedure have been provided the appropriate training required to perform this procedure.

2.1.2 The Project Manager is responsible for approving this procedure.

2.2 Project Coordinator

2.2.1 The Project Coordinator is responsible for providing updates to this procedure and ensuring copies of this procedure are maintained on each logging vehicle.

2.2.2 The Project Coordinator is responsible for communicating to the Logging Engineer all applicable information required to perform this procedure including, but not limited to the well construction information, logging parameters and waste disposal instructions. This information will be communicated through the use of Logging Request and Tracking Sheets.

2.3 Geophysical Logging Engineer

2.3.1 The Geophysical Logging Engineer is responsible for performing this procedure and providing the Project Coordinator with feedback to update the procedure when necessary.

3.0 Procedure

This procedure assumes that the following assumptions are met:

- The *Vehicle Preparation Procedure* (Chapter 2.0) is complete.
- The *Borehole Set Up Procedure* (Chapter 3.0) is complete.
- The *Power Up, Power Down Sequence* (Chapter 4.0) is complete.
- The settings on the 672-amplifier match Figure 8-1.
- A neutron moisture gauge (in its shipping container) is set beside the passive neutron tool.

The steps outlined below demonstrate just one method of setting up the CASASII LOG program for acquiring passive neutron data. Use these steps as a guide to become familiar with the CASASII LOG program. For more detail, consult the *CASASII LOG User's Manual* (Greenspan 1994).

General keyboard strokes are listed below to maneuver through the CASASII LOG program.

- Pressing <ESC> returns the user to the CASASII Main Menu.
- Pressing <ALT+Arrow Key Right/Left> moves the cursors 20 channels.
- Pressing <CTRL+Arrow Key Right/Left> moves the cursors 200 channels.

3.1 Invoke the CASASII LOG Program

3.1.1 Start from the Windows 95 desktop screen and restart in MS-DOS mode by performing the following keyboard stokes.

a. Press <CTRL+ESC> to display the Start Menu.

b. Point to "Shut Down . . ." using <Arrow Keys> and <Return↵>.

c. Use the <Arrow Keys> and move to "Restart the computer in MS-DOS mode?" <Return↵>.

d. An MS-DOS window appears displaying this syntax, C:\Windows>_.

e. Change directories; type CD.. and press <Return↵>.

f. New syntax appears, C:\>_.

g. Type LOG and <Return↵> to invoke the CASASII Main Menu screen.

h. The CASASII Main Menu appears with twelve commands labeled F1-F12. The current File Header and Data Directory are also displayed.

i. Press <CTRL+T> to disable the automated alarms. The LOG program makes a statement on the main menu screen "Alarms Disabled."

3.2 Make a New or Select an Existing Data Directory

3.2.1 From the CASASII Main Menu:

a. Press **F6** - *File/Directory Commands*. The File/Directory screen appears with six commands labeled F1-F6.

b. Option 1:
- Press **F1** – *Set Default Data Directory*. Select a directory that already exists. A list of directories that LOG can invoke appears. Use the <Arrow Keys> to select a directory, press the keyboard <Spacebar> to invoke it.

c. Option 2:
- Press **F3** – *Make Data Directory*. Create a new directory. Enter a directory name up to 8 characters. The LOG program automatically adds the directory suffix extension <*.DIR> <Return↵>.

- Press **F1** – *Set Default Data Directory*. Select the new directory created from the above step using the <Arrow Keys>, press the keyboard <Spacebar> to invoke it.

d. Press <ESC> to return to the CASASII Main Menu. Observe that the selected Data Directory name appears on the screen.

3.3 Passive Neutron Initialization and Set Up

3.3.1 From the CASASII Main Menu:

a. Press **F8** – *Load Initialization Defaults*. A list of initialization files that LOG can invoke appears.

b. Select <MOIST.INI> using the <Arrow Keys> and press the <Spacebar> to invoke it. This will load the correct 921-MCB and 672-amplifier settings. The CASASII Main Menu screen reappears.

c. Press **F1** – *LOG Initialization*. A 16-field initialization screen appears, which contains a default profile of values for the neutron moisture set up. The LOG program will prompt an Y/N response to edit entries. Enter yes (Y) and edit the fields as necessary, include a new File Header name. <Return↵>.

d. Press <ESC> to return to the CASASII Main Menu.

e. A check mark (✓) will appear to the right of **F1** - *Log Initialization*, indicating the data were successfully completed.

f. Option:
   - Press **F9** – *Save Initialization Defaults*. Save this edited initialization file if this set up profile is going to be used again in the future. A prompt box appears for a new file name and automatically adds the suffix extension <*.INI> <Return↵>.

3.4 Detector Pre Calibration and System Warm Up

3.4.1 From the CASASII Main Menu:

a. Press **F2** – *Detector Calibration*. The Calibration Screen appears with a graphical area for displaying spectral data in units of channels. Across the bottom, the screen has twelve function keys to input values, expand scale, and move two cursor pointers.

b. Press **F3** – *Real Time* and enter **100** seconds in the Acquire request. <Return↵>.

c. Press **F5** – *Start/Stop*. Begin acquiring a spectrum. A single peak will appear on or about channel **255** and near **300** counts per second.

d. Start the **15-minute** warm up period. After 15 minutes, proceed with the fine-gain adjustment.

Note: the passive neutron detector (optional instrumentation) is operationally verified by the Electronics Engineer in the geophysics laboratory prior to deployment for a project. The detector electronics records activity in counts per second and is not calibrated for varying environmental conditions or specific isotope concentrations.

3.5 Fine-Gain Adjustment

3.5.1 From the Calibration Screen: A 512-channel spectrum should display the neutron peak on or about channel 255. Check that a full spectrum is on the screen especially toward the lower channels that none is missing. If gain drift has occurred, then the 672-amplifier needs adjustment to meet this set up parameter.

a. Wait 15 minutes while the instruments in the equipment rack warm up.

b. Press F10 – *Clear*. Restart acquiring data when the acquisition time expires.

c. Press F12 – *Scale*. A new set of function keys are displayed that can zoom in and out and pan across the graphical display.

d. Press F3 - *<X2>* to expand scale and F4 – *X2>>* to pan across the graphical display to the neutron moisture peak.

e. Press F12 – *Return*. Return to the previous set of Scale controls.

f. Press F11 - *Cur1a/Cur1b/Cur2a/Cur2b*. Toggle to the cursor labeled Cur1b. Align cursor Cur1b over the centroid of the neutron peak at about channel 255. Note the Cur1b/neutron centroid channel number displayed on the screen.

g. If necessary, rotate the pot labeled "fine gain" a few units on the 672-amplifer until the Cur1b/neutron centroid align. Note the channel number.

h. Press F5 – *Start/Stop* or F10 – *Clear*. Restart collecting a spectrum. After adjusting the fine gain note if the Cur1b/neutron centroid align and the channel number.

i. Repeat the above steps until the Cur1b/centroid align. Gain drift usually occurs when the power is first applied and stops after about 15 minutes.

j. After the 15-minute warm up period expires and the fine gain adjustments made, collect a calibration spectrum and note the time in the field logbook.

k. Press F10 – *Clear*. Collect a calibration spectrum for the full 100 seconds.

3.6 From the Calibration Screen

3.6.1 An energy calibration is not assigned to the neutron spectrum. Verify that a full spectrum has been acquired and that the neutron spectrum has the expected shape.

3.6.2 Record the counts per second in the field logbook.

3.6.3 Press **F7** – *Precal/Postcal/Prebak/Postbak* and toggle to **Precal**.

3.6.4 Press **F6** – *Save*. Saves the calibration spectra to the default data directory. The LOG program automatically adds the file name extension <*CAB.CHN>

3.6.5 On the calibration screen, the LOG program prompts "Saved Data, Hit Any Key."

3.6.6 Press <ESC> to return to the CASASII Main Menu.

3.6.7 A check mark (✓) will not appear to the right of **F2** – *Detector Calibration* on the CASASII Main Menu.

3.7 Log Data Sheet and Stow the Neutron Moisture Gauge

3.7.1 If the logging engineer's professional judgment indicates that the NMLS is ready to log, then he/she will do the following:

a. Fill out the appropriate spaces on the Log Data Sheet and note in the logbook that the tool appears functional. Since this tool is not calibrated write "N/A" in both the Effective Calibration Date and Calibration Reference sections of the Log Data Sheet.

b. Stow the neutron moisture gauge in the source compartment of the truck.

3.8 Zero-Depth Reference and Setting the Initial Depth

The zero-depth reference is identified on the sonde housing. The zero-depth reference for a borehole is usually the top of the casing, but the ground surface or other reference is acceptable.

3.8.1 Note the borehole's zero-depth reference on the Log Data Sheet.

3.8.2 Place the sonde in the borehole.

3.8.3 Release the hoist brake on the OC.

3.8.4 Use the joystick and align the zero-depth references for both the sonde and borehole.

3.8.5 Reset the depth counter on the OC to 0.00 ft.

3.9 Depth Control

3.9.1 From the CASASII Main Menu:

a. Press **F3** – *Depth Control*. The Depth Control screen appears with four commands labeled F1-F4.

b. Press **F2** – *Enter*. Enter values for borehole and sonde depth. <Return↵>.

c. A Y/N prompt box appears - move the detector to a new depth? A yes (Y) answer will request a depth be entered; <Return↵>; followed by a second prompt - what speed should the hoist should move the sonde? Enter a value between 1-30 ft/min, <Return↵>. The LOG program automatically starts moving the sonde to the new depth. A no (N) answer will return to the CASASII Main Menu.

d. As the sonde moves, the Depth Control screen and OC both display current depth.

e. When starting depth is reached, use the joystick, move the sonde to the nearest 0.5 ft, and record the starting depth on the Log Data Sheet.

f. Press <ESC> to return to the CASASII Main Menu.

g. A check mark (✓) will appear to the right of **F3** – *Depth Control*, indicating the data was successfully completed.

3.10 Acquire Spectra and Begin Logging

3.10.1 From the CASASII Main Menu:

a. Press **F4** – *Acquire Spectra*. The Acquire Screen appears. This command may only be invoked if data were successfully completed for *Log Initialization* (F1), *Detector Calibration* (F2), and *Depth Control* (F3), which are indicated by a check mark (✓) to the right of each title. Proceed with data acquisition parameters. These parameters will be specified on the Logging Request & Tracking Sheet.

b. Press **F1** – *Continuous*. A velocity and sample interval must be specified. Those inputs are usually 1-ft per minute and a 0.25-ft sample interval. Enter a stop depth. **Note: No more than 400 files should be saved in any one directory. Change directories after 100 ft of logging.**

c. Press <Return↵>. The software controlled log run starts. The LOG program automatically adds the file suffix <*.CHN> and sequentially numbers the data files.

3.10.2 From the Instrument Cabin, monitor the following operations during logging:

- Spectrum collection
- Strain pressure
- Hydraulic fluid pressure
- Hydra-Gen® power output
- HV1 remains ON (subject to change)
- UPS power output

- Engine tachometer
- Engine gauges
- Hoist operation
- Crane position

3.10.3 Adjust fine gain as required, and record those adjustments on the Log Data Sheet.

3.10.4 Make entries as necessary on the Log Data Sheet and logbook.

3.11 Ending a Log Run and Moving the Sonde

3.11.1 From the Acquire Spectra window: When the sonde reaches the stop depth, the LOG program automatically terminates the data acquisition process. The F4 - Acquire Spectra window remains open, waiting on stand-by.

3.11.2 Record on the Log Data Sheet the last file number recorded, depth achieved, and approximate time. All this information is found on the final spectra file.

3.11.3 Press <ESC> to open to the CASASII Main Menu.

3.11.4 If a Repeat Log Run is required, proceed to that section now, if not continue.

3.11.5 Press **F3** – *Depth Control*. The depth control screen appears.

3.11.6 Press **F5** - *Move*. A prompt box appears - move the detector to a new depth? A Y (yes) answer will request a depth be entered; <Return↵>; followed by a second prompt - what speed should the hoist should move the sonde? Enter a value (1-30 ft/min), <Return↵>. The LOG program automatically starts moving the sonde to the new depth.

3.11.7 Press <ESC> to open to the CASASII Main Menu.

3.12 Check the Zero-Depth Reference

3.12.1 After the sonde has returned to 00.0 ft, record on the Log Data Sheet the discrepancy between the original and return zero-depth references.

3.12.2 Option 1:

- Logging will continue with a new log run, a Repeat Log Run, or changing locations. Change file name as appropriate, move to new depth, and acquire data.

3.12.3 Option 2:

- Logging is finished for the day; proceed with collecting a post calibration.

3.13 Detector Post Calibration Spectrum

3.13.1 Place the neutron moisture gauge next to the passive neutron tool.

3.13.2 From the CASASII Main Menu:

a. Press **F2** – *Detector Calibration*. The calibration screen appears.

b. Press **F3** – *Real Time* and enter **100** seconds. <Return↵>.

c. Press **F5** – *Start/Stop* to begin acquiring a spectrum.

d. Do not make fine gain adjustments - acquire a spectrum until time elapses.

e. Press **F7** – *Precal/Postcal/Prebak/Postbak* and toggle to **Postcal**.

f. Press **F6** – *Save*. Saves the calibration spectra to the default data directory. The LOG program automatically adds the file name extension <*CAA.CHN>

g. On the calibration screen, the LOG program prompts "Saved Data, Hit Any Key."

h. Press <ESC> to return to the CASASII Main Menu.

3.14 Transfer Data files and Shut Down the Logging Computer

3.14.1 Copy a set of spectra files from the logging computer to a mass storage device. Transfer this data, the Log Data Sheets, the Data Tracking Record, and the Logging Request & Tracking Sheet to the office for storage and analysis.

3.14.2 Complete and sign the Log Data Sheet(s).

3.14.3 Complete and initial the Data Tracking Record.

3.14.4 Complete appropriate sections and sign the Logging Request & Tracking Sheet.

3.14.5 Press <CTRL+ESC> on the Windows 95 desktop to display the Start Menu.

3.14.6 Use the <Arrow Keys> and move to "Shut Down . . ." <Return↵>.

3.14.7 Wait for Windows to shut down.

3.14.8 Turn OFF the power switch for the logging computer.

3.14.9 Turn OFF the NIM Bin power switch.

3.15 Equipment Rig Down

3.15.1 Remove the sonde from the cable head.

3.15.2 Remove the centralizer.

3.15.3 Stow the detector in the appropriate storage.

3.15.4 Remove the sheave wheel from the crane and stow the logging cable.

3.15.5 Drop the hoist compartment drape and secure.

3.15.6 Break down the crane, fold the boom into traveling position and secure.

3.15.7 Lift the outriggers and stow the pads.

3.15.8 Stow portable stairs and secure.

3.15.9 Close the Hydra-Gen® compartment door and secure.

3.15.10 Perform the *Power Up, Power Down Sequence* (Chapter 4.0) to finish.

3.15.11 Safety: walk around the vehicle and make a final equipment check before leaving the borehole.

4.0 Decontamination

As directed in the RWP or other project documentation, the logging cable and sonde may be wiped and surveyed as they are withdrawn from the borehole(s). If contamination is detected, the site radiological controls organization will direct decontamination of the affected components.

5.0 Waste Disposal

All waste generated during the execution of this procedure will be handled, packaged, labeled and disposed of in accordance with specific site requirements listed in project waste plans and/or other project documentation. The Project Coordinator will determine these requirements and provide the Logging Engineer specific waste disposal instructions on the Logging Request & Tracking Sheet. Waste generated may include, but is not limited to dirty rags from wiping the tools and cable as they are extracted from the borehole(s), and absorbent towels and plastic used to control small engine oil, hydraulic fluid and/or coolant leaks. All equipment will be maintained in good operating condition to prevent and/or minimize releases to the environment.

6.0 References

Greenspan, 1994, *Computer Automated Spectral Acquisition System II (CASASII) User Manual*, Greenspan, Inc., Houston, Texas.

U.S. Department of Energy (DOE) 2003. *Hanford Geophysical Logging Project Data Analysis Manual*, prepared for the U.S. Department of Energy by the S. M. Stoller Corporation, GJO-HGLP 1.6.3, Rev. 0, Richland, WA.

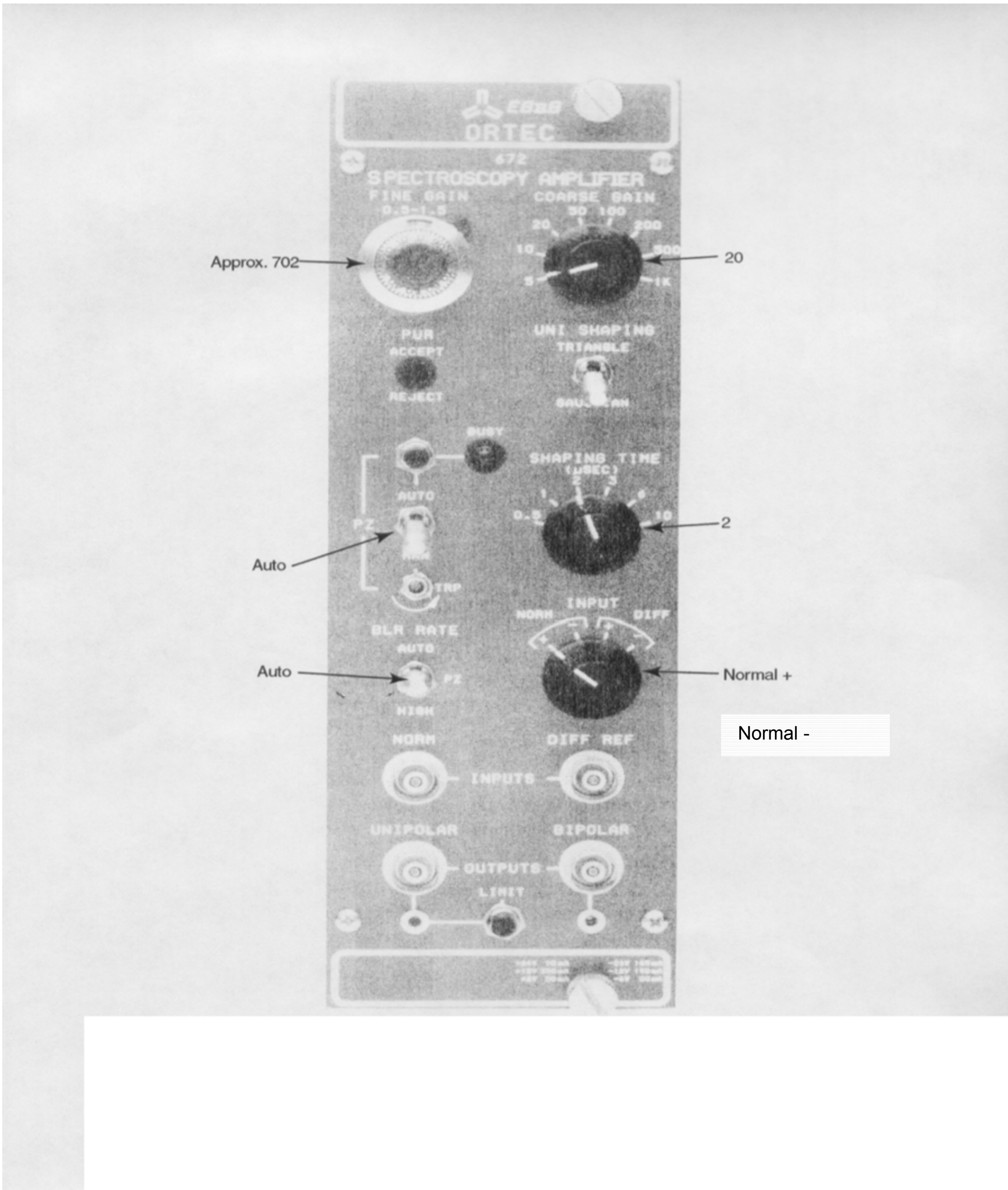

Figure 8-1. 672 Amplifier Settings

Chapter 9.0 Neutron Capture Logging Procedure

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Date

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1.0 Purpose And Scope

This logging procedure provides guidelines for performance of neutron capture borehole logging. Data acquired by the logging are used to delineate radioactive and non-radioactive components of waste sites during site characterization and other environmental investigations.

2.0 Responsibilities

2.1 Stoller Geophysical Logging Project Manager

2.1.1 The Project Manager is responsible for ensuring all personnel using this procedure have been provided the appropriate training required to perform this procedure.

2.1.2 The Project Manager is responsible for approving this procedure.

2.2 Project Coordinator

2.2.1 The Project Coordinator is responsible for providing updates to this procedure and ensuring copies of this procedure are maintained on each logging vehicle.

2.2.2 The Project Coordinator is responsible for communicating to the Logging Engineer all applicable information required to perform this procedure including, but not limited to the well construction information, logging parameters and waste disposal instructions. This information will be communicated through the use of Logging Request and Tracking Sheets.

2.3 Geophysical Logging Engineer

2.3.1 The Geophysical Logging Engineer is responsible for performing this procedure and providing the Project Coordinator with feedback to update the procedure when necessary.

2.3.2 The Geophysical Logging Engineer is responsible for obtaining and maintaining a Class B Commercial Driver's License with an air brake endorsement.

3.0 Procedure

Implementation of this procedure assumes the following have been completed:

- The *Vehicle Preparation Procedure* (Chapter 2.0) is complete.
- The *Borehole Set Up Procedure* (Chapter 3.0) is complete.
- The *Power Up, Power Down Sequence* (Chapter 4.0) is complete.
- The high voltage to the sonde is ON and LN2 is flowing.
- The settings on the 973-amplifier match Figure 9-1.

The steps outlined below demonstrate just one method of setting up the CASASII LOG program for acquiring spectral gamma-ray data employing the neutron-capture sonde. Use these steps as a guide to become familiar with the CASASII LOG program. For more detail, consult the *CASASII LOG User's Manual* (Greenspan 1994).

General keyboard strokes are listed below to maneuver through the CASASII LOG program.

- Pressing <ESC> returns the user to the CASASII Main Menu.
- Pressing <ALT+Arrow Key Right/Left> moves the cursors 20 channels.
- Pressing <CTRL+Arrow Key Right/Left> moves the cursors 200 channels.

3.1 Invoke the CASASII LOG Program

3.1.1 Start from the Windows 95 desktop screen and restart in MS-DOS mode by performing the following keyboard stokes.

a. Press <CTRL+ESC> to display the Start Menu.

b. Point to "Shut Down . . ." using <Arrow Keys> and <Return↵>.

c. Use the <Arrow Keys> and move to "Restart the computer in MS-DOS mode?" <Return↵>.

d. A MS-DOS window appears displaying this syntax, C:\Windows>_.

e. Change directories; type CD.. and press <Return↵>.

f. New syntax appears, C:\>_.

g. Type LOG and <Return↵> to invoke the CASASII Main Menu screen.

h. The CASASII Main Menu appears with twelve commands labeled F1-F12. The current File Header and Data Directory are also displayed.

i. Press <CTRL+T> to disable the automated alarms. The LOG program makes a statement on the screen “Alarms Off.”

3.2 Make a New or Select an Existing Data Directory

3.2.1 From the CASASII Main Menu:

a. Press **F6** - *File/Directory Commands*. The File/Directory screen appears with six commands labeled F1-F6.

b. Option 1:
Press **F1** – *Set Default Data Directory*. Select a directory that already exists. A list of directories that LOG can invoke appears. Use the <Arrow Keys> to select a directory, press the keyboard <Spacebar> to invoke it.
Option 2:

- Press **F3** – *Make Data Directory*. Create a new directory. Enter a directory name up to 8 characters. The LOG program automatically adds the directory suffix extension <*.DIR> <Return↵>.

- Press **F1** – *Set Default Data Directory*. Select the new directory created from the above step using the <Arrow Keys>, press the keyboard <Spacebar> to invoke it.

c. Press <ESC> to return to the CASASII Main Menu. Observe that the selected Data Directory name appears on the screen.

3.3 Neutron Capture Logging Setup and Borehole Information

3.3.1 From the CASASII Main Menu:

a. Press **F8** – *Load Initialization Defaults*. A list of initialization files that LOG can invoke appears.

b. Select <NCLS.INI> using the <Arrow Keys> and press the <Spacebar> to invoke it. This will load the correct 921-MCB setup, check the 973-amplifier settings. The CASASII Main Menu reappears.

c. Press **F1** – *LOG Initialization*. A 16-field initialization screen appears, which contains a default profile of values for the NCLS set up. The LOG program will prompt an Y/N response to edit entries. Enter yes (Y) and edit the fields as necessary, include a new File Header name. <Return↵>.

d. Press <ESC> to return to the CASASII Main Menu.

e. A check mark (✓) will appear to the right of **F1** - *LOG Initialization* indicating the data was successfully completed.

f. Option:

- Press **F9** – *Save Initialization Defaults*. Save this edited initialization file, if this set up profile is going to be used again in the future. A prompt box appears for a new file name and automatically adds the suffix extension <*.INI> <Return↵>.

3.4 Detector Pre-Survey Verification and System Warm-Up

3.4.1 Verify the sonde is properly installed in the field verifier.

3.4.2 Verify that if the neutron source is on hand, that it is as far away as possible from the detector during acquisition of verification spectra.

3.4.3 From the CASASII Main Menu:

a. Press **F2** – *Detector Calibration*. The Calibration Screen appears with a graphical area for displaying spectral data in units of channels. Across the bottom, the screen has twelve function keys to input values, expand scale, and move two cursor pointers.

b. Press **F3** – *Real Time* and enter **1,000** seconds in the Acquire request. <Return↵>.

c. Press **F5** – *Start/Stop* to begin acquiring a spectrum.

d. Start the **30-minute** warm up period. Proceed with the fine-gain adjustment as required to align calibration peaks with the appropriate channel. As determined at the sonde calibration.

e. Press **F10** - *Clear* again and collect a verification spectrum for the full **1,000** seconds.

3.5 Fine Gain Adjustment

3.5.1 From the Calibration Screen: The 921-MCB is set up to stabilize the1461-keV gamma-ray peak on the graphical display between channels 2120 and 2130. If gain drift has occurred, the 973-amplifier needs adjustment to meet this set up parameter.

a. Wait **15 minutes** while the instruments in the equipment rack warm up.

b. Press **F12** – *Scale* while acquiring a calibration spectrum to display a new set of function keys that can zoom in and out and pan across the graphical display.

c. Press **F1** - *<X1>* to expand scale and **F2** – *X1>>* to pan across the graphical display to the 1461-keV gamma-ray peak.

d. Press **F12** – *Return*. Return to the previous set of Scale controls.

e. Press **F11** - *Cur1a/Cur1b/Cur2a/Cur2b* and toggle to the cursor labeled **Cur1b**. Align cursor **Cur1b** over the centroid of the 1461-keV gamma-ray peak at about channel 2125. Note the Cur1b/1461-centroid channel number displayed on the screen.

f. If necessary, rotate the pot labeled "fine gain" a few units on the 973-amplifer until the Cur1b/1461-centroid align. Note the channel number.

g. Press **F5** – *Start/Stop* or **F10** – *Clear* to restart collecting a spectrum. After adjusting the fine gain note if the Cur1b/1461-centroid align and the channel number.

h. Repeat the above steps until the Cur1b/centroid align. Gain drift usually stops after about 15 minutes.

i. Press **F11** - *Cur1a/Cur1b/Cur2a/Cur2b* and toggle to the cursor labeled **Cur1a**. Align cursor **Cur1a** over the centroid of the 583-keV gamma-ray peak at about channel 850. Note the Cur1a/583-centroid channel number displayed on the screen.

j. After the **30-minute** warm-up period expires and any fine gain adjustments have been made, collect a verification spectrum.

k. Press **F10** – *Clear* again and collect a verification spectrum for the full **1,000** seconds.

3.6 Two-Point Calibration And Save

3.6.1 From the Calibration Screen: After a verification spectrum is collected, align cursors **Cur1a** and **Cur1b** over the centroid of the **583.2**-keV gamma-ray peak (about channel 850) and **2614.5**-keV gamma-ray peak (about channel 3805), respectively.

a. Press **F1** – *Calibration*. Enter the following energy values in the LOG prompt boxes, **583.2** and **2614.5**. <Return↵>.

b. Press **F7** – *Precal/Postcal/Prebak/Postbak* and toggle to **Precal**.

c. Press **F6** – *Save*. Saves the calibration spectra to the default data directory. The LOG program automatically adds the file name extension <*CAB.CHN>

d. On the calibration screen, the LOG program prompts "Saved Data, Hit Any Key."

e. Note that the graphical area is now calibrated in units of energy (keV).

f. Press **F9** – *Channel*. Toggle between units of channel and energy to check settings.

g. Press <ESC> to return to the CASASII Main Menu.

h. A check mark (✓) will appear to the right of **F2** – *Detector Calibration*, indicating the data was successfully completed.

3.7 Analyze Spectrum and Compare Results to Acceptance Criteria

3.7.1 Analyze the pre-verification spectrum and compare the results to acceptance criteria.

a. Copy the pre-calibration file <*CAB.CHN> to the laptop computer for analysis.

b. See the desktop instructions for analyzing Field Verification Spectra and the most recent published acceptance criteria to complete this step in the guide.

3.8 Log Data Sheet and Stow KUTh Check -Source

3.8.1 If the Logging Engineer's professional judgment indicates that the NCLS is ready to log, then he/she will do the following:

a. Fill out the appropriate spaces on the Log Data Sheet.

b. Make a note in the logbook that the verification spectrum has met the acceptance criteria.

c. Place the KUTh check-source in the storage compartment, secure and lock it.

d. Position the centralizer on the sonde when logging boreholes greater than or equal to 6 in. in diameter.

3.9 Neutron Source Installation

3.9.1 Remove neutron source in shipping shield from source storage compartment or designated source storage area and place it within easy reach of the well head.

3.9.2 Position and zero the logging tool in the well to be logged. Then pull the tool out of the well so the source can be installed.

3.9.3 Remove ^{252}Cf source from source shipping shield using source-handling tool, and install in source receptacle on logging tool and lightly tighten. Remove source-handling tool from source and immediately signal an assistant at the logging truck hoist to lower the tool into the well to the top of the cablehead. The source handler shall have been trained on safe handling of the source (Chapter 13.0, *Safe Operating and Storage for the Neutron Capture Probe Source*).

3.9.4 Reverse steps for source removal.

3.10 Detector Pre-Survey Qualitative Spectrum Evaluation

3.10.1 Because analysis of neutron-capture spectra acquired in the vadose zone is linked to ^{40}K concentrations determined from passive gamma (SGLS) logs, it is imperative that the prompt-gamma peak for ^{39}K (770.3 keV) exhibit good resolution. In certain situations, other energy peaks from other isotopes may also be used for this evaluation. At a depth (or depth range) predetermined by the technical lead, acquire a spectrum (or spectra) using a count time also determined by the technical lead (usually 300 seconds).

3.10.2 Evaluate the resolution of the prompt-gamma energy peak(s) of interest. Based on the logging engineer's qualitative evaluation of the peaks, the count time may be adjusted up or down to ensure good data quality. Confer with the technical lead as needed.

3.11 Zero-Depth Reference and Setting the Initial Depth

3.11.1 Establish the zero depth reference on the sonde. It may be a scribe line marked around the bottom of the turned-down section of the housing or may be some other location on the sonde housing. The zero-depth reference for a borehole is usually the top of the casing, but the ground surface or other reference is acceptable.

3.11.2 Note the borehole's zero-depth reference on the Log Data Sheet.

3.11.3 Release the hoist brake on the OC.

3.11.4 Use the joystick and align the zero-depth references for both the sonde and borehole.

3.11.5 Reset the depth counter on the OC to 0.00 ft.

3.12 Depth Control

3.12.1 From the CASASII Main Menu:

a. Press **F3** – *Depth Control*. The Depth Control screen appears with four commands labeled F1-F4.

b. Press **F2** – *Enter*. Enter values for borehole and sonde depth. <Return↵>.

c. A Y/N prompt box appears - move the detector to a new depth? A yes (Y) answer will request a depth be entered; <Return↵>; followed by a second prompt - what speed should the hoist should move the sonde? Enter a value (between 1-30 ft/min), <Return↵>. The LOG program automatically starts moving the sonde to the new depth. A no (N) answer will return to the CASASII Main Menu.

d. As the sonde moves, the Depth Control screen and OC both display current depth.

e. When starting depth is reached, use the joystick, move the sonde to the nearest 0.5 ft, and record the starting depth on the Log Data Sheet.

f. Press <ESC> to return to the CASASII Main Menu.

g. A check mark (✓) will appear to the right of **F3** – *Depth Control*, indicating the data was successfully completed.

3.13 Acquire Spectra and Begin Logging

3.13.1 From the CASASII Main Menu:

a. Press **F4** – *Acquire Spectra*. The Acquire Screen appears. This command may only be invoked if data were successfully completed for *Log Initialization* (F1), *Detector Calibration* (F2), and *Depth Control* (F3), which are indicated by a check mark (✓) to the right of each title. Proceed with data acquisition parameters.

b. Press **F1** – *Move-Stop-Acquire*. Input a depth increment (usually 1.0 ft), counting time (300 sec. real time), and a stop logging depth.

c. Press <Return↵>. The software controlled log run starts. The LOG program automatically adds the file suffix <*.CHN> and sequentially numbers the data files.

3.14 Monitor the Following Operations

3.14.1 From the instrument cabin, monitor the following operations during logging:

- Spectrum collection
- LN2 flow
- Hydraulic fluid pressure
- Strain pressure
- Hydra-Gen® power output
- HV1 remains ON
- UPS power output
- Engine tachometer
- Engine gauges
- Hoist operation
- Crane position

3.14.2 Adjust gain stabilization as required and record those adjustments on the Log Data Sheet. List the affected depth and file number.

3.14.3 Make entries as necessary on the Log Data Sheet and logbook.

3.15 Ending a Log Run and Moving the Sonde

3.15.1 From the Acquire Spectra window: When the sonde reaches the stop depth, the LOG program automatically terminates the data acquisition process. The **F4** - *Acquire Spectra* window remains open, waiting on stand-by.

3.15.2 Record on the Log Data Sheet the last file number recorded and depth achieved. All this information is found in the final spectrum file.

3.15.3 Press <ESC> to open to the CASASII Main Menu.

3.15.4 If a Repeat Log Run is required, proceed to that section now; if not, continue.

3.15.5 Press **F3** – *Depth Control*. The depth control screen appears.

3.15.6 Press **F5** - *Move*. A prompt box appears - move the detector to a new depth? A Y (yes) answer will require a depth to be entered; <Return↵>; followed by a second prompt - what speed should the hoist should move the sonde? Enter a value (1-30 ft/min), <Return↵>. The LOG program automatically starts moving the sonde to the new depth. When at the new depth, the sonde can be moved manually and the software will continually refresh the depth location of the sonde. The tool should be moved to the surface under the manual control of a logging engineer. A second logging engineer should remove the neutron source from the sonde by reversing the procedure found in Section 3.9.

3.15.7 Press <ESC> to open to the CASASII Main Menu.

3.16 Repeat Surveys

3.16.1 Logging system performance should be evaluated by performance of a repeat survey of at least 10 percent of the length of the initial survey. Exceptions of this value may be granted based on specific project goals.

3.16.2 Log interval that should be considered for repeat surveys are intervals of moderate detector response, intervals that include overlaps of consecutive log runs, or intervals within which the gamma-ray intensity increases or decreases.

3.16.3 Interval of repeat surveys should be recorded on the Log Data Sheet as an ordinary log run and should be identified as a repeat survey.

3.17 Check the Zero-Depth Reference

3.17.1 After having removed the neutron source, and with the sonde returned to 0.0 ft, record on the Log Data Sheet the discrepancy between the original and return zero-depth references.

3.17.2 Option 1:

- Logging will continue with a new log run, a Repeat Log Run, or changing locations. Change file name as appropriate, move to new depth, and acquire data. If changing locations, remove and stow neutron source.

3.17.3 Option 2:

- Logging is finished for the day; proceed with collecting a post-survey calibration spectrum. The post-survey calibration is performed in the same location as the pre-survey calibration.

3.18 Detector Post-Survey Verification

3.18.1 Remove the neutron source from the sonde with the handling tool and install in the storage container as discussed in Section 5.6.

3.18.2 Detector post-survey verification will be performed at the end of each log survey or daily as required for a particular project. Detector post-survey calibration shall be performed as described in Section 3.4, "Detector pre-survey verification"

3.19 Termination of Logging

At the conclusion of logging, Sections 3.20 through 3.22 should be followed.

3.20 Exit CASASII LOG Program

3.20.1 Press <ESC> on the keyboard while the CASASII Main Menu is open.

3.20.2 The LOG program prompts an Y/N box – Do you wish to quit now?

3.20.3 Press yes (Y) to close CASASII Main Menu and exit to the MS-DOS window.

3.20.4 This syntax appears, C:\LOG>_.

3.20.5 Type EXIT. <Return↵>. “Windows is starting” appears.

3.21 Transfer Data Files and Shut Down the Logging Computer

3.21.1 Copy the set of spectrum files just collected from the logging computer to the mass storage device. Transfer these data, the Log Data Sheets, the Data Tracking Record, and the Logging Request and Tracking Sheet to the office for storage and analysis.

3.21.2 Complete and sign the Log Data Sheet(s), and complete entries in the system logbook and sign and date the appropriate page(s).

3.21.3 Complete and initial the Data Tracking Record.

3.21.4 Complete appropriate sections and sign the Logging Request & Tracking Sheet.

3.21.5 Press <CTRL+ESC> on the Windows 95 desktop to display the Start Menu.

3.21.6 Use the <Arrow Keys> and move to “Shut Down . . .” <Return↵>.

3.21.7 Wait for Windows 95 to shut down.

3.21.8 Turn OFF the power switch for the logging computer.

3.21.9 Turn OFF the HV1 toggle switch.

3.21.10 Turn OFF the NIM Bin power switch.

3.22 Equipment Rig Down

3.22.1 Stow and lock the KUTh verifier in the storage compartment.

3.22.2 Remove the sonde from the cable head, stow the sonde in the tray, and attach the LN2 dispensing system. Turn the LN2 ON.

3.22.3 Remove the sheave wheel from the crane and stow the logging cable.

3.22.4 Drop the hoist compartment drape and secure.

3.22.5 Break down the crane, fold the boom into traveling position, and secure.

3.22.6 Lift the outriggers and stow the pads.

3.22.7 Secure loose items, stow portable stairs, and secure doors.

3.22.8 Close the Hydra-Gen® compartment door and secure.

3.22.9 Walk around the truck before moving it.

4.0 Decontamination

As directed in the RWP or other project documentation, the logging cable and sonde may be surveyed and/or wiped as they are withdrawn from the borehole(s). If contamination is detected, the site radiological control organization will direct decontamination of the affected components.

5.0 Waste Disposal

All waste generated during the execution of this procedure will be handled, packaged, labeled and disposed of in accordance with specific site requirements listed in project waste plans and/or other project documentation. The Project Coordinator will determine these requirements and provide the Logging Engineer specific waste disposal instructions on the Logging Request and Tracking Sheet. Waste generated may include, but is not limited to dirty rags from wiping the tools and cable as they are extracted from the borehole(s), and absorbent towels and plastic used to control small engine oil, hydraulic fluid and/or coolant leaks. All equipment will be maintained in good operating condition to prevent and/or minimize releases to the environment.

6.0 References

Greenspan, 1994, *Computer Automated Spectral Acquisition System II (CASASII) User Manual*, Greenspan, Inc., Houston, Texas.

U.S. Department of Energy (DOE) 2003. *Hanford Geophysical Logging Project, Data Analysis Manual*, prepared for the U.S. Department of Energy by the S. M. Stoller Corporation, GJO-HGLP 1.6.3, Rev. 0, Richland, WA.

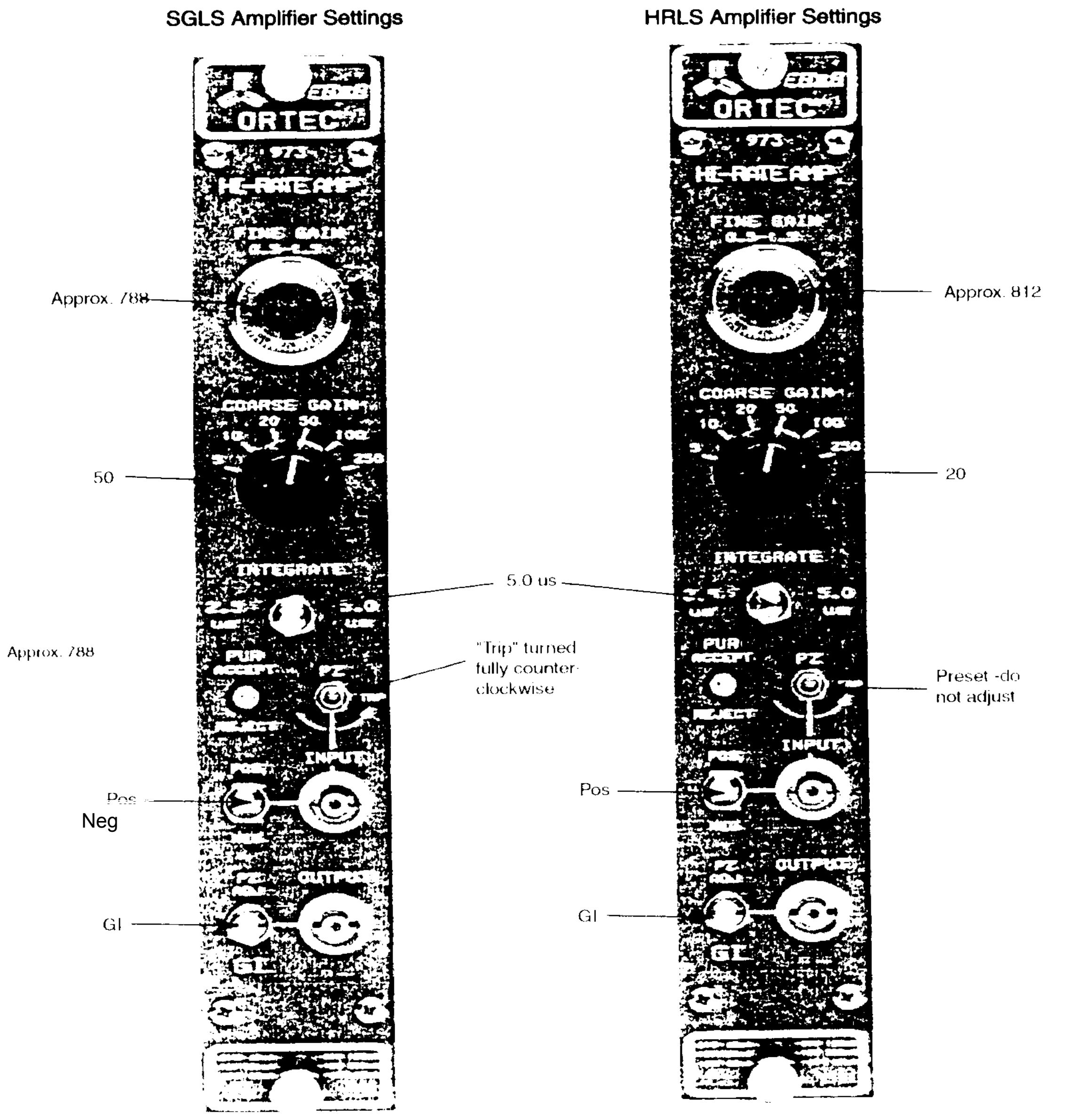

Figure 9-1. 973 Amplifier Settings

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1.0 Purpose And Scope

This procedure provides the guidelines for conducting directional gamma-ray surveys. Directional gamma-ray logging is conducted at discrete depths of interest in boreholes and may be used to identify the radial position of point source gamma-ray emitting radionuclides. The depth locations of interest shall be determined by passive gamma-ray logging.

2.0 Responsibilities

2.1 Stoller Geophysical Logging Project Manager

2.1.1 The Project Manager is responsible for ensuring all personnel using this procedure have been provided the appropriate training required to perform this procedure.

2.1.2 The Project Manager is responsible for approving this procedure.

2.2 Project Coordinator

2.2.1 The Project Coordinator is responsible for providing updates to this procedure and ensuring copies of this procedure are maintained on each logging vehicle.

2.2.2 The Project Coordinator is responsible for communicating to the Logging Engineer all applicable information required to perform this procedure including, but not limited to the well construction information, logging parameters and waste disposal instructions. This information will be communicated through the use of Logging Request and Tracking Sheets.

2.3 Geophysical Logging Engineer

2.3.1 The Geophysical Logging Engineer is responsible for performing this procedure and providing the Project Coordinator with feedback to update the procedure when necessary.

3.0 Procedure

Implementation of this procedure assumes the following have been completed:

- The *Preparations Procedure* (Chapter 2.0) is complete.
- The *Borehole Set Up Procedure* (Chapter 3.0) is complete.
- The *Power Up, Power Down Sequence* (Chapter 4.0) is complete.
- The HPGe detector is connected and installed in the directional tool housing.
- The high voltage to the sonde is ON.
- The settings on the 973 amplifier match Figure 10-1.

The steps outlined below demonstrate just one method of setting up the CASASII LOG program for acquiring spectral gamma-ray data employing the directional gamma sonde. Use these steps as a guide to become familiar with the CASASII LOG program. For more detail, consult the *CASASII LOG User's Manual*, 1994 by Greenspan, Inc., Houston, Texas.

General keyboard strokes are listed below to maneuver through the CASASII LOG program.

- Pressing <ESC> returns the user to the CASASII Main Menu.
- Pressing <ALT+Arrow Key Right/Left> moves the cursors 20 channels.
- Pressing <CTRL+Arrow Key Right/Left> moves the cursors 200 channels.

3.1 Invoke the CASASII LOG Program

3.1.1 Start from the Windows 95 desktop screen and restart in MS-DOS mode by performing the following keyboard stokes.

a. Press <CTRL+ESC> to display the Start Menu.

b. Point to "Shut Down . . ." using <Arrow Keys> and <Return↵.

c. Use the <Arrow Keys> and move to "Restart the computer in MS-DOS mode?" <Return↵.

d. A MS-DOS window appears displaying this syntax, C:\Windows>_.

e. Change directories; type CD C:\ and <Return ↵.

f. New syntax appears, C:\>_.

g. Change directories; type CD LOG:\ and <Return ↵.

h. New syntax appears, C:\LOG>_.

i. Type LOG and <Return↵ to invoke the CASASII Main Menu screen.

j. The CASASII Main Menu appears with twelve commands labeled F1-F12. The current File Header and Data Directory are also displayed

k. Press <CTRL+T> to disable the automated alarms. The LOG program makes a statement on the screen "Alarms Off."

3.2 Create a New or Select an Existing Data Directory

3.2.1 From the CASASII Main Menu:

a. Press **F6 -** *File/Directory Commands.* The File/Directory screen appears with six commands labeled F1-F6.

b. Option 1:
- Press **F1** – *Set Default Data Directory*. Select a directory that already exists. A list of directories that LOG can invoke appears. Use the <Arrow Keys> to select a directory, press the keyboard <Spacebar> to invoke it. Observe that the selected Data Directory name appears on the screen.

c. Option 2:
- Press **F3** – *Make Data Directory*. Create a new directory. Enter a directory name up to 8 characters. The LOG program automatically adds the directory suffix extension <*.DIR> <Return↵.
- Press **F1** – *Set Default Data Directory*. Select the new directory created from the above step using the <Arrow Keys>, press the keyboard <Spacebar> to invoke it.
- Press <ESC> to return to the CASASII Main Menu.

3.3 Directional Gamma Logging Setup and Borehole Information

3.3.1 From the CASASII Main Menu:

a. Press **F8** – *Load Initialization Defaults*. A list of initialization files that LOG can invoke appears.

b. Select <SGLS.INI> using the <Arrow Keys> and press the <Spacebar> to invoke it. This will load the correct 921-MCB setup and check the 973-amplifier settings. The CASASII Main Menu reappears.

c. Press **F1** – *LOG Initialization*. A 16-field initialization screen appears, which contains a default profile of values for the directional gamma set up. The LOG program will prompt an Y/N response to edit entries. Enter yes (Y) and edit the fields as necessary, include a new File Header name. <Return↵.

d. Press <ESC> to return to the CASASII Main Menu.

e. A check mark (✓) will appear to the right of **F1** - *Log Initialization* indicating the data was successfully completed.

f. Option:
   - Press **F9** – *Save Initialization Defaults*. Save this edited initialization file, if this set up profile is going to be used again in the future. A prompt box appears for a new file name and automatically adds the suffix extension <*.INI> <Return↵.

3.4 Detector Pre-Survey Calibration and System Warm-Up

3.4.1 Install two lantern mantels in the slot of the directional shield.

3.4.2 From the CASASII Main Menu:

a. Press **F2** – *Detector Calibration*. The Calibration Screen appears with a graphical area for displaying spectral data in units of channels. Across the bottom, the screen has twelve function keys to input values, expand scale, and move two cursor pointers.

b. Press **F3** – *Real Time* and enter **1,000** seconds for HPGe detectors of 35% or less of relative efficiency, or **500** seconds for detectors of greater than 35% relative efficiency. <Return↵>.

c. Press **F5** – *Start/Stop* to begin acquiring a spectrum.

d. Start the **30-minute** warm up period. Proceed with the fine-gain adjustment.

3.5 Fine Gain Adjustment

3.5.1 From the Calibration Screen: The 921-MCB is set up to stabilize the1461-keV gamma-ray peak on the graphical display between channels 2120 and 2130. If gain drift has occurred, the 973-amplifier needs adjustment to meet this set up parameter.

a. Wait **15 minutes** while the instruments in the equipment rack warm up.

b. Analyze the post calibration spectrum <*CAA.CHN> from the previous day.

c. Press **F12** – *Scale* while acquiring a calibration spectrum to display a new set of function keys that can zoom in and out and pan across the graphical display.

d. Press **F1 -** *<X1>* to expand scale and **F2** – *X1>>* to pan across the graphical display to the 1461-keV gamma-ray peak.

e. Press **F12** – *Return*. Return to the previous set of Scale controls.

f. Press **F11** - *Cur1a/Cur1b/Cur2a/Cur2b* and toggle to the cursor labeled **Cur1b**. Align cursor **Cur1b** over the centroid of the 1461-keV gamma-ray peak at about channel 2125. Note the Cur1b/1461-centroid channel number displayed on the screen.

g. Rotate the pot labeled "fine gain" a few units on the 973-amplifer until the Cur1b/1461-centroid align. Note the channel number.

h. Press **F5** – *Start/Stop* or **F10** – *Clear* to restart collecting a spectrum. After adjusting the fine gain note if the Cur1b/1461-centroid align and the channel number.

i. Repeat the above steps until the Cur1b/centroid align. Gain drift usually stops after about 15 minutes.

j. Press **F11** - *Cur1a/Cur1b/Cur2a/Cur2b* and toggle to the cursor labeled **Cur1a**. Align cursor **Cur1a** over the centroid of the 583-keV gamma-ray peak at about channel 850. Note the Cur1a/583-centroid channel number displayed on the screen.

k. After the **30-minute** warm up period expires and the fine gain adjustments made, collect a calibration spectrum.

l. Press **F10** – *Clear* again and collect a verification spectrum for the full **500 or 1,000** seconds.

3.6 Two-Point Calibration and Save

3.6.1 From the Calibration Screen: After a calibration spectrum is collected, align cursors **Cur1a** and **Cur1b** over the centroid of the **583.2**-keV gamma-ray peak (about channel 850) and **2614.5**-keV gamma-ray peak (about channel 3805), respectively.

a. Press **F1** – *Calibration*. Enter the following energy values in the LOG prompt boxes, **583.2** and **2614.5**. <Return↵>.

b. Press **F7** – *Precal/Postcal/Prebak/Postbak* and toggle to **Precal**.

c. Press **F6** – *Save*. Saves the calibration spectra to the default data directory. The LOG program automatically adds the file name extension <*CAB.CHN>

d. On the calibration screen, the LOG program prompts "Saved Data, Hit Any Key."

e. Note that the graphical area is now calibrated in units of energy (keV).

f. Press **F9** – *Channel*. Toggle between units of channel and energy to check settings.

g. Press <ESC> to return to the CASASII Main Menu.

h. A check mark (✓) will appear to the right of **F2** – *Detector Calibration*, indicating the data was successfully completed.

3.7 Analyze Spectrum and Compare Results to Acceptance Criteria

3.7.1 Analyze the pre-calibration spectrum and compare the results to acceptance criteria.

a. Copy the pre-calibration file <*CAB.CHN> to the laptop computer for analysis.

b. See the desktop instructions for analyzing Field Verification Spectra and the most recent published acceptance criteria to complete this step in the guide.

3.8 Log Data Sheet and Stow KUTh Check-Source

3.8.1 If the logging engineer's professional judgment indicates that the SGLS is ready to log, then he/she will do the following:

a. Fill out the appropriate spaces on the Log Data Sheet.

b. Make a note in the field logbook that the verification spectrum has met the acceptance criteria.

c. Remove the lantern mantels.

d. Position the **centralizer** on the sonde when logging boreholes greater than or equal to 6 in. in diameter.

3.9 Zero-Depth Reference and Setting the Initial Depth

3.9.1 Establish the zero depth reference on the sonde. It may be a scribe line marked around the bottom of the turned-down section of the housing or may be some other location on the sonde housing. The zero-depth reference for a borehole is usually the top of the casing, but the ground surface or other reference is acceptable. Tool reference zero shall coincide with the reference used for the spectral gamma-ray log survey since these data define the depth location for the directional survey.

3.9.2 Casing specifications shall be verified with previous spectral gamma log survey, record differences on the Log Data Sheet. At active sites, where ground surface is estimated and/or borehole installation is recent, the casing stickup shall be recorded.

3.9.3 A directional azimuth position should be established and marked on the casing or other identifiable means.

3.10 Depth Control

3.10.1 From the CASASII Main Menu:

a. Press **F3** – *Depth Control.* The Depth Control screen appears with four commands labeled F1-F4.

b. Press **F2** – *Enter.* Enter values for borehole and sonde depth. <Return↵.

c. A Y/N prompt box appears - move the detector to a new depth? A yes (Y) answer will request a depth be entered; <Return↵; followed by a second prompt - what speed should the hoist should move the sonde? Enter a value (between 1-30 ft/min), <Return↵. The LOG program automatically starts moving the sonde to the new depth. A no (N) answer will return to the CASASII Main Menu.

d. As the sonde moves, the Depth Control screen and OC both display current depth.

e. When starting depth is reached, use the joystick, move the sonde to the nearest 0.5 ft, and record the starting depth on the Borehole Data Sheet.

f. Press <ESC> to return to the CASASII Main Menu.

g. A check mark (✓) will appear to the right of **F3** – *Depth Control,* indicating the data was successfully completed.

3.11 Acquire Spectra and Begin Logging

3.11.1 Align well head directional fixture with casing reference mark and secure to well head.

3.11.2 Attach alignment tubing to top of logging probe, lower probe into borehole and secure tubing in wellhead directional fixture.

3.11.3 Position logging tool at "reference" position. (Center of primary detector is located at depth reference datum.)

3.11.4 Move probe to predefined depth location for directional measurements.

3.11.5 Acquire stationary measurements at each of 8 locations (points around the compass) at times specified by the project scientist. Document measurements on Borehole Data Sheet. Do not twist probe cable beyond 180 degrees in well head fixture.

3.11.6 Review results and identify locations for intermediate measurement directions.

3.11.7 Advance the probe to the next predefined depth location for directional measurement set and repeat the previous two steps.

3.11.8 Return probe to surface, removing alignment tubes as required and removing well set directional measurement fixture. Verify well-head fixture retained orientation with casing reference mark.

3.12 Operations During Logging

3.12.1 From the Instrument Cabin, monitor the following operations during logging:

- Spectrum collection
- Hydraulic fluid pressure
- Strain pressure
- Hydra-Gen® power output
- HV1 remains ON
- UPS power output
- Engine tachometer
- Engine gauges
- Hoist operation
- Crane position

3.12.2 Adjust gain stabilization as required and record those adjustments on the Log Data Sheet. List the affected depth and file number.

3.12.3 Make entries as necessary on the Log Data Sheet and in the logbook.

3.13 Ending a Log Run and Moving the Sonde

3.13.1 When all of the measurements at a particular depth location have been collected, move the sonde to another location or end the log run and return to the surface (zero reference point).

3.13.2 Press <ESC> to open to the CASASII Main Menu.

3.13.3 Press **F3** – *Depth Control.* The depth control screen appears.

3.13.4 Press **F5** - *Move*. A prompt box appears - move the detector to a new depth? A Y (yes) answer will request a depth be entered; <Return↵; followed by a second prompt - what speed should the hoist should move the sonde? Enter a value (1-30 ft/min), <Return↵. The LOG program automatically starts moving the sonde to the new depth or to the zero reference point.

3.13.5 Press <ESC> to open to the CASASII Main Menu.

3.14 Check the Zero-Depth Reference

3.14.1 After the sonde has returned to 0.0 ft, record on the Log Data Sheet the discrepancy between the original and return zero-depth references.

3.14.2 If logging is finished for the day; proceed with collecting a post-survey calibration spectrum.

3.15 Collect Post-Survey Verification Spectrum

* Install two lantern mantels in the slot of the directional shield.

3.15.1 From the CASASII Main Menu:

a. Press **F2** – *Detector Calibration*. The calibration screen appears.

b. Press **F3** – *Real Time* and enter **1,000** seconds for HPGe detectors of 35% or less of relative efficiency, or **500** seconds for detectors of greater than 35% relative efficiency. <Return↵>.

c. Press **F5** – *Start/Stop* to begin acquiring a spectrum.

d. Do **not** make any fine gain adjustments; acquire a spectrum until time elapses.

e. Press **F7** – *Precal/Postcal/Prebak/Postbak* and toggle to **Postcal**.

f. Press **F6** – *Save*. Saves the calibration spectra to the default data directory. The LOG program automatically adds the file name extension <*CAA.CHN>.

g. On the calibration screen, the LOG program prompts "Saved Data, Hit Any Key."

h. Press <ESC> to return to the CASASII Main Menu.

3.16 Exit CASASII LOG Program

3.16.1 Press <ESC> on the keyboard while the CASASII Main Menu is open.

3.16.2 The LOG program prompts an Y/N box – Do you wish to quit now?

3.16.3 Press yes (Y) to close CASASII Main Menu and exit to the MS-DOS window.

3.16.4 This syntax appears, C:\LOG>_.

3.16.5 Type EXIT. <Return↵. "Windows is starting" appears.

3.17 Transfer Data Files and Shut Down the Logging Computer

3.17.1 Copy the set of spectra files just collected from the logging computer to the mass storage device. Transfer these data, the Log Data Sheets, the Data Tracking Record, and the Logging Request and Tracking Sheet to the office for storage and analysis.

3.17.2 Complete and sign the Log Data Sheet(s), and complete entries in the system logbook and sign and date the appropriate page(s).

3.17.3 Complete and initial the Data Tracking Record.

3.17.4 Complete appropriate sections and sign the Logging Request and Tracking Sheet.

3.17.5 Press <CTRL+ESC> on the Windows 95 desktop to display the Start Menu.

3.17.6 Use the <Arrow Keys> and move to “Shut Down . . .” <Return↵.

3.17.7 Wait for Windows 95 to shut down.

3.17.8 Turn OFF the power switch for the logging computer.

3.17.9 Turn OFF the HV1 toggle switch.

3.17.10 Turn OFF the NIM Bin power switch.

3.18 Equipment Rig Down

3.18.1 Remove and stow the lantern mantels.

3.18.2 Remove the sonde from the cable head, stow the sonde in the tray, and attach the LN_2 dispensing system. Turn the LN_2 ON.

3.18.3 Remove the sheave wheel from the crane and stow the logging cable.

3.18.4 Drop the hoist compartment drape and secure.

3.18.5 Break down the crane, fold the boom into traveling position, and secure.

3.18.6 Lift the outriggers and stow the pads. Secure loose items, stow portable stairs, and secure doors.

3.18.7 Close the Hydra-Gen® compartment door and secure.

3.18.8 Walk around the truck before moving it.

4.0 Decontamination

As directed in the RWP or other project documentation, the logging cable and sonde may be wiped and surveyed as they are withdrawn from the borehole(s). If contamination is detected, the site radiological controls organization will direct decontamination of the affected components.

5.0 Waste Disposal

All waste generated during the execution of this procedure will be handled, packaged, labeled and disposed of in accordance with specific site requirements listed in project waste plans and/or other project documentation. The Project Coordinator will determine these requirements and provide the Logging Engineer specific waste disposal instructions on the Logging Request and Tracking Sheet. Waste generated may include, but is not limited to dirty rags from wiping the tools and cable as they are extracted from the borehole(s), and absorbent towels and plastic used to control small engine oil, hydraulic fluid and/or coolant leaks. All equipment will be maintained in good operating condition to prevent and/or minimize releases to the environment.

6.0 References

Greenspan, 1994. *Computer Automated Spectral Acquisition System II (CASASII) User Manual*, Greenspan, Inc., Houston, Texas.

U.S. Department of Energy (DOE) 2003. *Hanford Geophysical Logging Project Data Analysis Manual*, prepared for the U.S. Department of Energy by the S. M. Stoller Corporation, GJO-HGLP 1.6.3, Rev. 0, Richland, WA.

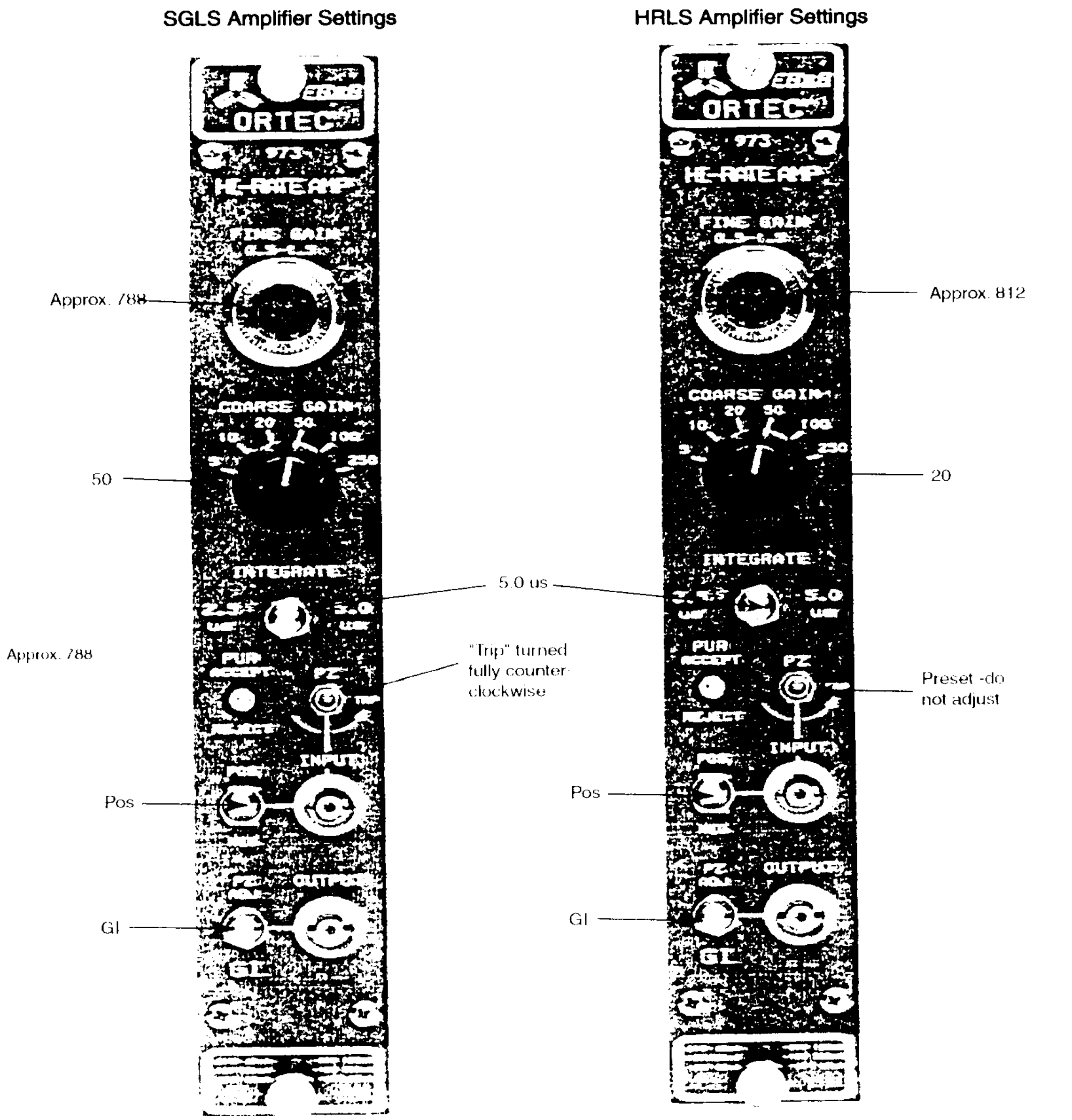

Figure 10-1. 973 Amplifier Settings

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____________________________________ ______________________

Brian W. Mathis, Manager Date

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1.0 Purpose And Scope

1.1 General Information

1.1.1 Dewar Identification: the permanently mounted dewars in the logging trucks will be referred to as "receivers" for this procedure. The freestanding dewars that are equipped with the pressure building feature are referred to a "supply" dewars.

1.1.2 Valve Identification: the valves that are used in the following procedure have been given an alphabetical description designation that refers to Figure 11-1.

1.1.3 Ball Valve Operation: the valves on the liquid nitrogen system are configured to be closed when the valve handle is perpendicular to the piping and the direction of nitrogen flow through the valve body. They are configured to be open when the valve handle is parallel to the piping and the direction of nitrogen flow through the valve body.

1.1.4 Contamination Control Procedures: this procedure must be performed in accordance with Hanford Radiological Control Manual (HNF-5173). The flexible cryogenic transfer hose will be kept outside the controlled area fence. A plastic sleeve must be on the hose prior to the nitrogen transfer. Pass the hose through the fence and attach it to the receiver dewar. The hose must be surveyed by an RCT before withdrawing through the fence.

1.1.5 Pressure Building Feature: the supply dewars are equipped with a coil that encircles the dewar between the inner and outer stainless steel jacket. The function of the coil is to circulate a small amount of liquid nitrogen through a warmer surface, causing it to vaporize, and then reintroducing the gas into the dewar. The purpose of this feature is to increase the head pressure of the supply dewar to improve the efficiency of the liquid transfer process. This is accomplished by opening the pressure building (PB) valve A on the supply dewar.

2.0 Responsibilities

2.1 Stoller Geophysical Logging Project Manager

2.1.1 The Project Manager is responsible for insuring all personnel using this procedure have been provided the appropriate training required to perform this procedure.

2.1.2 The Project Manager is responsible for approving this procedure.

2.2 Project Coordinator

2.2.1 The Project Coordinator is responsible for providing updates to this procedure and ensuring copies of this procedure are maintained on each logging vehicle.

2.3 Geophysical Logging Engineer

2.3.1 The Geophysical Logging Engineer is responsible for performing this procedure and providing the Project Coordinator with feedback to update the procedure when necessary

3.0 Precautions and Limitations

3.1 Warnings

Liquid Nitrogen can cause severe frostbite and can cause asphyxiation by displacing oxygen in a confined area. Handlers of this material must familiarize themselves with the Material Safety Data Sheet maintained in the Health and Safety Notebook. All personnel should have proper training and instructions for the specific cryogenic liquid and equipment involved.

3.2 Personal Protective Equipment (PPE)

Handlers of liquid nitrogen must use the appropriate PPE, including the following: insulated leather gloves, raincoat, long-sleeve shirt or jacket, long pants, and closed top leather shoes.

4.0 Procedure

4.1 Filling the Dewar

4.1.1 The truck tarp must remain up and the truck dewar's service door must remain open during this procedure to ensure adequate ventilation.

4.1.2 Close all ball valves on the receiver and supply dewars.

4.1.3 Check the sonde's auto fill electrical switch is OFF. Turn OFF if necessary.

4.1.4 Remove the protective end caps from the transfer hose and connect it to the liquid lines on the two dewars. The attachment point for the receiver dewar is located on the outside of the truck below the receiver dewar's service door. This fitting is protected with a brass cap. The attachment point for the supply dewar is located on the main liquid valve (F). Tighten the hose fittings with a wrench. Ensure the drain valve (G), located on the transfer hose, is closed.

4.1.5 Open the pressure building valve (A) on the supply dewar. Given time, the supply pressure can build to 200 psi.

4.1.6 Set the position of the four valves at the top of the receiving dewar:

a. Open the main liquid valve (B) to receive flow.

b. Open the liquid valve (C) to the copper fill line leading to the hose connection to receive flow.

c. Leave valve (D) to the sonde's auto fill system closed.

d. Open the vent valve (E). The receiving dewar is now actively expelling nitrogen gas from the dewar. Stay out of the winch compartment during the fill operation.

e. Open the main liquid valve (F) on the supply dewar slowly to prevent thermal shock to the piping and container, and possible excessive pressure build up within the system. The supply dewar is now actively transferring liquid nitrogen to the receiver dewar. Monitor the supply dewar's pressure gauge. As the transfer progresses the pressure steadily drops. Adequate transfer pressure is above 40 psi.

4.1.7 Monitor the receiver dewar and shut off the liquid nitrogen flow according to Step 4.1.10. The receiver dewar is full when the sight indicator glass reads full, when liquid nitrogen spits from the receiver dewar's vent, or when the pressure from the supply dewar drops below 40 psi.

4.1.8 If necessary, artificially build the receiver dewar's pressure to 15 psi or greater before disconnecting the transfer hose. This is accomplished by closing the receiving dewar's vent valve after it is full. Some residual pressure in the supply dewar will transfer to the receiver dewar boosting its head pressure. If 15 psi cannot be attained, reconnect the transfer hose to a second supply dewar and repeat the above steps. Pressure over 22 psi is automatically vented through the receiver dewar's safety relief valve. Immediately after a transfer, low head pressure lacks enough energy to push liquid nitrogen through the auto fill system. It may take up to 24 hours for the liquid nitrogen to build adequate head pressure to maintain operating levels. Inadequate head pressure could result in a warm tool.

4.1.9 When the transfer is complete, close all valves in the following order:

a. Vent valve (E) on receiver dewar.

b. Main liquid valve (F) on supply dewar after adequate pressure is built in the receiver dewar.

c. Liquid valves (B and C) at the top of the receiver dewar.

d. Pressure builder valve (A) on the supply dewar.

e. Open the pressure bleed valve (G) and allow the back pressure to escape before disconnecting the transfer hose. Avoid contact with any liquid draining from the valve.

4.1.10 Disconnect the transfer hose. Take care to avoid contact with any liquid remaining in the hose. Have an HPT perform the radiological survey before removing the hose from the fence. Place the end caps on the hose for storage. Store the hose, wrench, and PPE together for reuse.

5.0 References

Hanford Radiological Control Manual, HNF-5173, Revision 3.

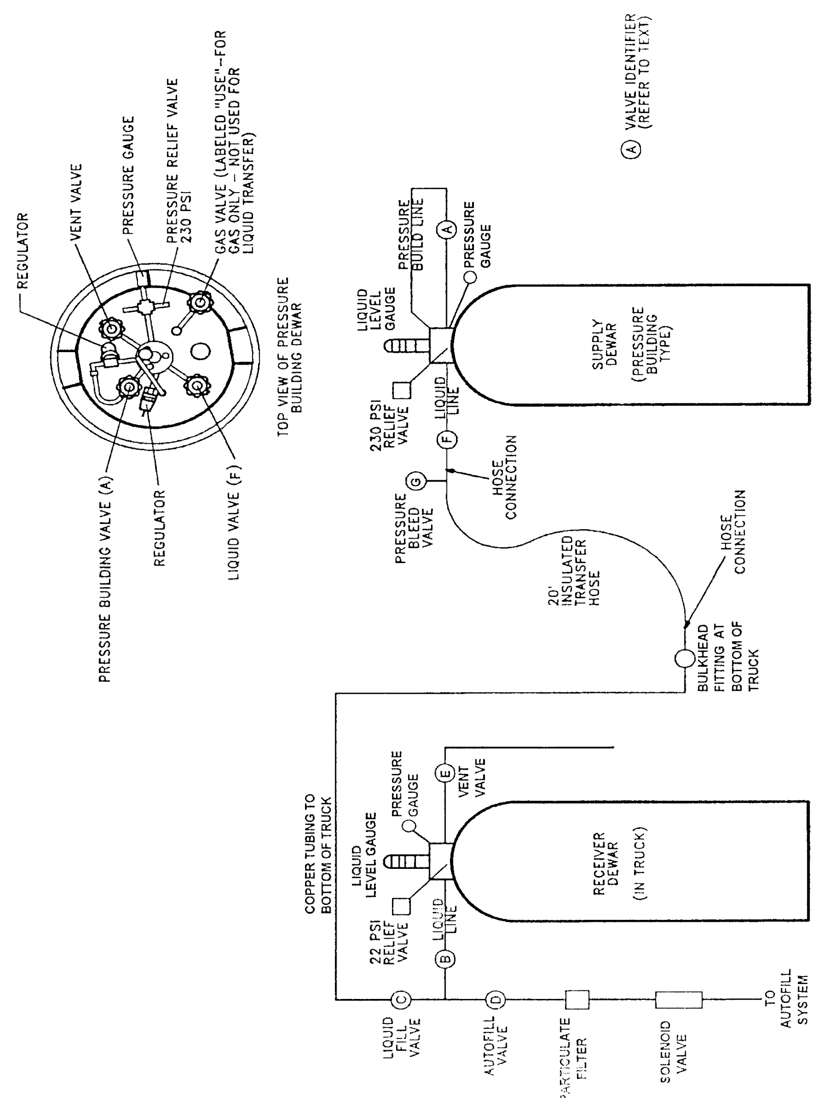

Figure 11-1. Liquid Nitrogen Storage and Distribution System

Prepared By:

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Alan W. Pearson Date
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Approved By:

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Brian W. Mathis, Manager Date
S. M. Stoller Corp., Hanford Office

1.0 Purpose And Scope

This procedure describes the steps to be implemented when a borehole sonde becomes snagged in a borehole/well preventing normal retrieval of the sonde. The following conditions apply to implementing this procedure:

- Gamma 1, 2, or 4 is the vehicle utilized for acquisition of spectral gamma-ray data, and the vehicles are equipped with a weight sensor that is located between the crane and the sheave wheel.

- Crane support legs are installed between the ground surface and the end of the crane.

- A standard sonde housing employing the planar (HRLS), 35%, or 70% HPGe detectors is being utilized for logging.

- The Computer Automated Spectral Acquisition System II (CASASII) logging program is managing depth control.

The steps outlined below demonstrate a method of removing a sonde safely from a borehole snag. They are to be utilized as a guide for the initial stabilization of a snag. Additional methods may have to be developed for different borehole conditions related to the various casing configurations encountered in borehole/wells.

2.0 Responsibilities

2.1 Stoller Geophysical Logging Project Manager

2.1.1 The Project Manager is responsible for insuring all personnel using this procedure have been provided the appropriate training required to perform this procedure.

2.1.2 The Project Manager is responsible for approving this procedure.

2.2 Project Coordinator

2.2.1 The Project Coordinator is responsible for providing updates to this procedure and ensuring copies of this procedure are maintained on each logging vehicle.

2.3 Geophysical Logging Engineer

2.3.1 The Geophysical Logging Engineer is responsible for performing this procedure and providing the Project Coordinator with feedback to update the procedure when necessary.

3.0 Operating Conditions

CASASII controls all aspects of the logging process once initial conditions are set including data collection, data recording, hoist movement, and sensor monitoring. During move routines, the weight sensor is monitored. Hoist movement is terminated if a sonde becomes snagged in a borehole and the weight applied to the weight sensor exceeds 1,000 pounds. A circuit located inside the operations console controls this limit electronically. Both the CASASII depth control program and the manual (joystick) depth control are locked-out until the over weight condition is removed. During an over weight condition, CASASII is operating in the background but does not respond to keyboard commands.

CAUTION: For personal safety, ensure that the strain has been removed from the logging cable before approaching the wellhead because the cable is under significant tension at the weight sensor cutoff value.

4.0 Procedure

4.1 Request Assistance, Record Sonde Depth and Weight

4.1.1 If an over weight event occurs, call the project coordinator with a status report and suggestions for further assistance. Clearing the snag may require the assistance of additional personnel.

4.1.2 Record the depth, weight, and liquid nitrogen flow that are displayed on the operations console at the time of the snag.

4.1.3 Check the signal monitor panel for HV, ± 24V, and ±12V status and note any changes.

4.1.4 If the CASASII status screen appears, review the alarms and confirm the over weight warning. Do not reboot the logging computer.

4.2 Remove Load Pin Fuse

4.2.1 To regain manual (joystick) depth control, remove the electrical fuse labeled “load pin” located on the sensor panel. Removing the fuse terminates electrical power to the weight sensor’s circuit.

4.2.2 Twist the fuse cap, pull out the assembly, and save the two pieces for re-installation later. With the fuse removed, the weight sensor’s read out on the operations console and the CASASII status screen will both display negative numbers. Manual control of the winch is now restored and the winch can be operated using the joystick even though the logging cable is still under tension.

4.3 Remove Cable Weight

4.3.1 Use the joystick to lower the sonde to a depth slightly below the snag.

4.3.2 Watch the depth display, logging cable, and sheave wheel for movement and tension relief. If the logging cable and sheave wheel resume their normal logging condition, the sonde has probably dropped free of the snag. But if the logging cable becomes slack and the sheave wheel drops -- as if the sonde is sitting on the bottom of a borehole, the sonde is probably still snagged and has not dropped free.

4.3.3 Set the hoist brake on the operations console.

4.4 Reinstall Load Pin Fuse

4.4.1 Reinstall the load pin fuse after removing the over weight. Keyboard commands may or may not be restored to CASASII after reinstalling the load pin fuse. However, the weight sensor can now be employed to help monitor weight on the logging cable.

4.4.2 Verify that the weight indicated on the readout is appropriate for a free hanging sonde and length of cable in the borehole/well. If after reinstalling the load pin fuse, lower than normal weight is indicated on the readout and cable slack is observed, the sonde is probably still snagged and may have to be removed by other means than described in this guide. Consult with the project coordinator.

4.5 Check Sonde for Free Movement

4.5.1 Perform an inspection of the logging cable and sheave wheel. Look for broken, cracked, or distorted connections, especially on the sheave wheel, that could break or fail during sonde retrieval. Do not proceed without help if damage is found.

4.5.2 Use a hand mirror to check the well condition (obstacle), provided sufficient sunlight is present and the snag is not located too deep in the borehole/well.

4.5.3 Retrieve the sonde by hand to a point past the snag. If the sonde will not move, other methods will have to be employed for retrieval. Consult with the project coordinator.

4.5.4 Once the sonde is lifted clear of the snag, attach the cable clamp to the logging cable to prevent the sonde from slipping back downward.

4.5.5 Spool excess logging cable until the weight on the cable clamp is relieved. Apply the hoist break and remove the cable clamp.

4.5.6 Retrieve the sonde slowly because the cemented Kevlar® connection inside the cable head has been stressed and possibly broken. Any sudden jarring may cause the cable head to fail.

4.5.7 Slowly spool the remaining logging cable and monitor the weight sensor until the sonde reaches the surface.

4.6 Post Sonde Removal, Inspections, Tests, and Reporting

4.6.1 A cable head subjected to the conditions described above must be tested and re-fabricated before being reused for logging. Inspection of the cable must be performed to identify possible broken or shorted electrical conductors and damaged sheathing.

4.6.2 The logging engineer shall prepare a report describing the circumstances surrounding the event and provide the report to the project manager.

Chapter 13.0 Safe Operating and Storage for the Neutron Capture Probe Source

Prepared By:

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1.0 Purpose And Scope

1.1 Purpose

This procedure governs the use of the source for the neutron capture probe. This procedure implements as low as reasonably achievable (ALARA) practices.

1.2 Scope

The requirements of this procedure address personnel qualifications and responsibilities, facilities, dosimetry, equipment, equipment operation, documentation, and emergency response to be implemented during the use of the neutron capture measurement probe source. These requirements are specified in accordance with the *PHMC Radiological Control Manual* (HNF-5173). This procedure is divided into three sections. The first, main section, applies to all applications and uses of the device, including testing and borehole logging. The two appendices contain specific requirements for specific equipment or facility operation and emergency response.

2.0 Personnel Responsibilities

2.1 Radiological Control

2.1.1 For static neutron probe source testing and borehole logging operations, the Radiological Control (RadCon) organization is responsible for:

a. Reviewing and approving the safe operating and emergency procedures.

b. Developing Radiation Work Permits (RWP) for use of the probe source.

c. Performing the necessary surveillance and appraisal of radiological operations and activities.

d. Providing personnel for sealed source integrity testing every 6 months.

e. Providing trained and qualified personnel to perform the required radiation and contamination surveys.

2.2 Borehole Geophysics Manager

2.2.1 The Geophysics Manager is responsible for:

a. Writing and submitting safe operating and emergency procedures for the neutron capture measurement probe source for approval.

b. Providing adequate training for personnel for the safe use and control of the radioactive sources and generating devices.

2.3 Material Balance Area (MBA) Custodian

2.3.1 The MBA Custodian must have current training as specified in the “Nuclear Material Control and Accountability Custodian Training Program Plan,” and Appendix C of *Materials Control and Accountability Plan,* (HNF-MP-5477). The MBA custodian must also have current Radiological worker training, as required by the RWP, as described in HNF-5173. The Hanford Site Contractor, Fluor Hanford, will assign the MBA custodians. S.M. Stoller Corporation is not a DOE qualified possessing contractor and therefore cannot act as MBA custodians.

2.4 Logging Engineer

2.4.1 The logging engineer has the primary responsibility for ensuring that well logging is performed in a safe manner in accordance with this procedure. The logging engineer shall supervise all neutron well logging operations for open installations (field use), specifically ensuring that before probe source operation:

a. RadCon and facility operations conduct a pre-job safety briefing identifying plant alarm systems, RWP requirements, location of radiation boundaries (if any), and all adjacent areas where personnel could be affected by the probe source operation.

b. All personnel within the 5 mrem/h boundary wear proper dosimetry, as identified in the RWP.

c. The applicable RWP, and safe operation and emergency procedures are available at the job site.

d. The well logging area is properly posted.

e. Personnel exposures are kept ALARA and below site administrative limits.

2.4.2 The logging engineer shall verify or have RadCon verify that boundaries are correctly or conservatively located, and that the neutron source and any activated materials are properly shielded and secure following each operation. A neutron detection instrument such as a “Snoopy” shall be used for these verifications.

2.4.3 The logging engineer shall ensure:

a. That radiation postings are removed, the area cleaned up, and the proper facility notifications are made at the completion of the job.

b. The proper handling, use, and storage procedures for the probe source are implemented.

3.0 Administrative Controls

3.1 Radiation Work Permit

3.1.1 The facility Radiological Control Organization section shall generate an RWP for approval and use of the radioactive source(s) used with the neutron capture system. All personnel involved with use of this device shall read and understand all provisions of the RWP associated with the use of neutron sources. Each individual, indicating that they have read and understand the applicable RWP must sign the RWP Acknowledgement sheet. The RWP will specify the radiological controls required for all personnel involved with the use of the neutron source.

3.2 Safe Operating and Emergency Procedures

3.2.1 A current copy of the main body of this procedure and applicable appendices shall be located at all locations where the neutron capture devices are in use and where the neutron sources are stored.

3.3 Dosimetry Requirements

3.3.1 Dosimetry requirements will be identified on the RWP.

3.4 Leak Test Requirements

3.4.1 RadCon shall conduct sealed source leak testing of the source(s) used with the neutron capture probe immediately before its initial first use and at least every six months.

3.5 Inspection and Maintenance of the Neutron Source(s)

3.5.1 The MBA custodian, or his/her alternate, shall visually check for defects in the outer source encapsulation before its use on any day. Defective or suspected defective equipment or source encapsulation shall not be used and shall be tagged out of service. If, during the use of the source, personnel have reason to believe that the outer encapsulation may have been breached, all personnel in the immediate area will be notified and RadCon will be notified to verify the integrity of the capsulation. Example: Source NSD-78, is a doubly encapsulated special form source that has been tested under high temperature (2400 ^{o}F) for 1 hour, under a 20,000 pound crushing force, and under a 10,000 shear force and was shown to not leak. If this source or another special form (49 CFR 173.476) source were simply dropped during normal handling, an emergency would not be declared (unless visual inspection did provide evidence that the capsulation was violated) because the demonstrated strength of the capsulation far exceeds the conditions that could normally be imposed upon the capsule by a handling drop. In the event of a source-handling drop, an integrity test would be obtained from RadCon prior to further use.

3.6 Operations Log

3.6.1 An operations log shall be maintained at each location where the neutron source is used. The beginning and ending times that a source is in use will be recorded in this log. A source checkout log is required if an individual is using the source. The following information is required on a source checkout log:

- MBA custodian's name
- Source identification number
- Source isotope
- Source activity (Ci)
- Signature and payroll number of individual authorizing use
- Signature and payroll number of responsible source user
- Date and time source is removed from storage
- Destination for source use
- Date and time source is returned to storage
- Signature and payroll number of individual receiving source for storage

3.7 Instrumentation

3.7.1 Instrumentation for monitoring radiological conditions will be determined and operated by RadCon personnel.

4.0 References

49 CFR 173.476, "Approval of Special Form Class 7 (radioactive) Materials," *Code of Federal Regulations*, as amended.

PHMC Radiological Control Manual, HNF-5173, Revision 3.

Sealed Radioactive Source Control, HNF-PRO-387, Revision 1.

Materials Control and Accountability Plan, HNF-MP-5477, Revision 3.

Attachment A. Use Of Isotopic Neutron Source For Borehole Logging

1.0 Scope

This procedure establishes the requirements for the safe use of radioactive neutron sources associated with the development, testing, calibration, and operation of well-logging neutron probes at well sites. This attachment shall be used in conjunction with the main body of this procedure.

2.0 General Requirements

2.1 Personnel Requirements

The RWP will state the requirements for Radiological Control Technician (RCT) coverage. The RWP will also specify the radiological worker training required for all personnel who enter the radiation area established for use of the source. All personnel will exercise the principles of ALARA during use of radioactive sources.

2.2 Source Handling And Associated Probe Equipment

An encapsulated ^{252}Cf source is used to produce the high-energy neutrons necessary for activation of materials to be assayed using the neutron-capture logging system (NCLS). ^{252}Cf emits neutrons with an average energy of several MeV. A gamma-ray detector is used along with the neutron source to detect the distinctive prompt gamma rays emitted during neutron capture by non-radioactive isotopes. The detector and source together are referred to as the NCLS probe. The NCLS probe will be used at the Hanford Calibration Models during annual calibrations of the system, and whenever the technical lead determines there is a need for additional calibration or testing of the system. Otherwise, the system will be deployed in a variety of boreholes throughout the Hanford Site.

The probe will be suspended in boreholes by a logging winch and hoist using 7/8-inch logging cable, or an equivalent logging armored cable capable of supporting the weight of the probe. Data collection and processing electronics housed in the logging truck will be used to store and interpret data acquired from downhole measurements.

The encapsulated source is further contained within a roughly cylindrical source holder that has been machined so that it can be threaded into a hole in the housing of the logging tool. The insertion and removal of the source holder is performed using a special handling tool. The handling tool is effectively a (minimum) 28-in. pole with a socket driver at the end. One end of the source holder is hexagonal, allowing the socket to fit over that end. Within the source-handling tool is a long, thin rod, threaded at the end, extending from the handle end to the socket end. The rod can be turned independently of the socket. During source handling, the socket is placed over the hexagonal end of the source holder, and the thin rod is threaded into a small hole in the hexagonal end of the source holder, thus affixing the source holder to the socket end of the handling tool. The source holder can then be unscrewed from the logging tool housing and placed in the source shield (or the other way around) without the risk of dropping the source holder in the process. Once in place, the thin rod is unscrewed from the source holder, and the handling tool is pulled free from the source holder.

The neutron source will be stored within the source holder—there should never be a reason to remove the encapsulated source from the source holder during any logging activity—in the shielded cask when not in use. The source-handling tool is designed to maintain a minimum 28-in. separation of extremities from the source capsule. The dose rate at the surface of any shipping cask will not exceed 200 mrem/h.

2.3 Site Requirements

The encapsulated neutron source is authorized to be removed from the shielding/storage container to be used with the gamma ray detectors per the signed and approved procedure, when the requirements of the RWP are met. The source will be stored in a shielded shipping cask at the site approved by the Hanford Site RadCon and Safeguards/Security organizations. The shipping cask must either be secured in a locked enclosure or secured to a permanent and not easily movable structure to prevent unauthorized movement or theft.

2.4 Usage Requirements

ALARA principles will be followed in the use of the neutron source.

When personnel are handling the source (such as when the source is being attached to the neutron capture probe), the shortest interval of time possible should be used. Sources whose on-contact total dose rates exceed 50 mrem/h will be handled using remote implements that provide for a minimum 28-in. separation between the capsule and extremities. Handling of the sources will meet all requirements of the job-specific RWP. For the neutron capture probe, the source should be left deployed within the calibration wells between measurements to take advantage of the shielding provided by the sediments surrounding the well or materials in the calibration models. Personnel will maintain a safe distance, as directed by the RCT, between themselves and the source when their proximity to the source is not required. These time, distance, and shielding precautions will minimize personnel exposures. Because the expected personnel dose rates are negligible when the source is deployed in a borehole, no special precautions need to be taken during data acquisition.

When the source is being used to perform measurements not in a borehole, a temporary radiation area may need to be established and posted, as required by RadCon and the RWP. RCT coverage will be determined by the RWP requirements.

Attachment B. Emergency Response

1.0 Scope

This attachment establishes the response to emergency situations that may occur during well logging operations.

2.0 General Requirements

The logging engineer has the necessary training and experience to handle emergency situations, and it is the logging engineer's primary responsibility to insure the safety of all personnel during all operations. It is also very important that the logging engineer recognize that an emergency situation exists before any overexposures occur.

It is always best to err on the side of caution, and not to proceed when safety indicators conflict.

Since it is impossible to foresee all potential accident scenarios, it is imperative that if an emergency situation arises, that not only this document be followed but that common sense and good judgment be exercised.

3.0 Emergency Situation

3.1 In an emergency situation, do not panic. Remain calm, think clearly, and (if it can be safely performed) determine the extent of the problem by using a survey meter and/or by a visual examination. Remember to employ the concepts of time, distance and shielding to minimize exposures.

3.2 Do not try to recover from the event by yourself as you may make the situation worse. With the area under surveillance, notify the manager of the probe source and the RadCon area supervisor and determine what should be done next. A recovery plan will be developed.

3.3 If necessary, communicate the possible dangers to emergency response personnel.

3.4 As soon as is practical, document in detail the events of the emergency and any actions taken at the scene.

4.0 Personnel Overexposure

Notify the manager of the probe source and RadCon immediately if you suspect that you or someone else has been overexposed.

5.0 Unauthorized Entry Into A Radiologically-Controlled Area

Unauthorized entry into a radiation-controlled area is a serious offense. The logging engineer shall record the individual's name and payroll number and report it to the manager of the probe source and RadCon. The engineer shall try to establish and document where the individual went and how long they were within the radiation area.